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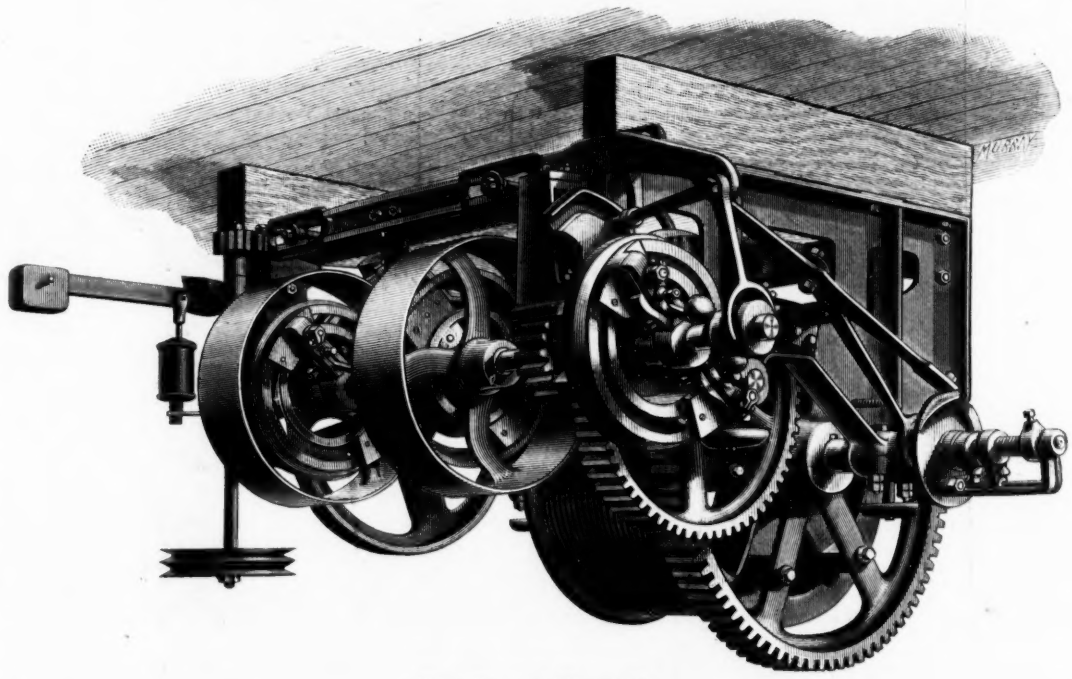
No. 4 Plate Planing Machine.

The engraving represents a machine designed to plane two edges of a plate up to 30 feet in length by 10 feet in width at one setting, or any length by shifting. The advantage of such an arrangement is manifest, for it not only admits of finishing the entire plate at two settings, but it saves room; for, with the usual type of machine, which cuts but one edge at a time, the plate has to be set transversely as well as parallel to the bed, requiring a space in both directions equal to its greatest length. The planer has sufficient power to work 1″ steel plates with ease, and is therefore serviceable for heavy marine boilers and ship plating. The carriage on the longer bed has two tool slides facing each other, and cutting in reverse directions, one of them having a vertical slide with a swivel for cutting a strip off the edge of a sheet and for planing internal angles. The transverse bed is arranged to swivel on a base-plate by means of a pinion and circular rack, giving a variation of ten degrees in either direction from a right angle. As its carriage has much less to do than the other, it has but one tool slide, cutting in one direction, with a quick-return motion. The clamping bar is bolted to the uprights, and the plates are held in position by hand screw-jacks which can be quickly placed and removed. Owing to the space between the clamping bar and the table, the machine can be used for planing beams, keels and a variety of other work. Each carriage has an independent driving gear operated by two belts, for the forward and backward movements, separately shifted. The builders of the above machine are Bement, Miles & Co., Philadelphia, Pa.

The Frisbie Elevator.

In our issue of Oct. 27, 1888, we illustrated an elevator made by The D. Frisbie Co., which was intended for light service only, and was driven by an open and a crossed belt, which were shifted to change the direction of motion, the winding arm being driven by means of a worm and wheel.



THE FRISBIE ELEVATOR.

On this page, and on page 2, we present engravings of an elevator intended for the heaviest and most severe service, and in which it has been the aim to embody every feature which could in any way add to the durability and safety of the machine.

In this machine the belts are not shifted, but the two pulleys upon which they run are alternately connected or disconnected from the shaft, by means of the well-known Frisbie friction clutches. Worm gearing is also dispensed with, being replaced by spur gears, the proportions of which give about thirty turns of the first shaft to one of the drum, the pulleys being 24″ diameter for a 6″ belt.

Above the pulleys is a bar, which is racked along by means of the pinion, which is worked from the car. To the center of this bar is attached an arm, which throws the clutches, and on the vertical shaft, to which the pinion is fixed, is a cam, which, when both clutches are disconnected, allows the weighted lever, shown at the left, to fall and apply a friction brake to the rim of a wheel, which is on the intermediate shaft, and a part of which is shown just below the pulleys. This friction brake is made powerful enough to absolutely control the machine when fully loaded, and if suddenly applied, when the car is running at the high speed intended, would produce an unpleasant jar. To obviate this is the purpose of the dash-pot, shown just below the lever. A piston, which is attached to the lever, works within the cylinder of the dash-pot against the air, and there are adjustable openings, by means of which the time consumed in the descent of the lever, and the full application of the brake, may be varied at pleasure, this action being designed to be made slow enough to do away with all jar caused by too sudden stopping.

At the right hand extremity of the pulley shaft is a friction clutch, constructed upon the same principles as the others, but so made as to be thrown in by the centrifugal motion of the fly-balls shown, a motion which takes place when, for any reason, the speed of the shaft is increased beyond the normal rate.

If, for instance, the belt should break, the car would commence to descend, but as soon as its motion became faster than the regular rate, the fly-balls would apply the clutch and check it. In order to prevent them from releasing it again, as soon as the speed becomes sufficiently reduced, the first thing done by the clutch, when thrown in by the balls, is to move the cam plate shown above the clutch, and, by means of the bell crank shown, move inwards the cone which is upon the end of the shaft. This, by moving in between the balls, prevents their return and the consequent release of the clutch. As the friction ring of this clutch is attached to the frame, when it is thrown in the shaft is stopped, and as the shaft to which it is applied makes thirty revolutions to one of th drum, this action takes place very quickly, and before the speed of the car can get much above the normal rate.

The right-hand extremity of the drum shaft is threaded, and has upon it a collar which, as the shaft revolves, travels back and

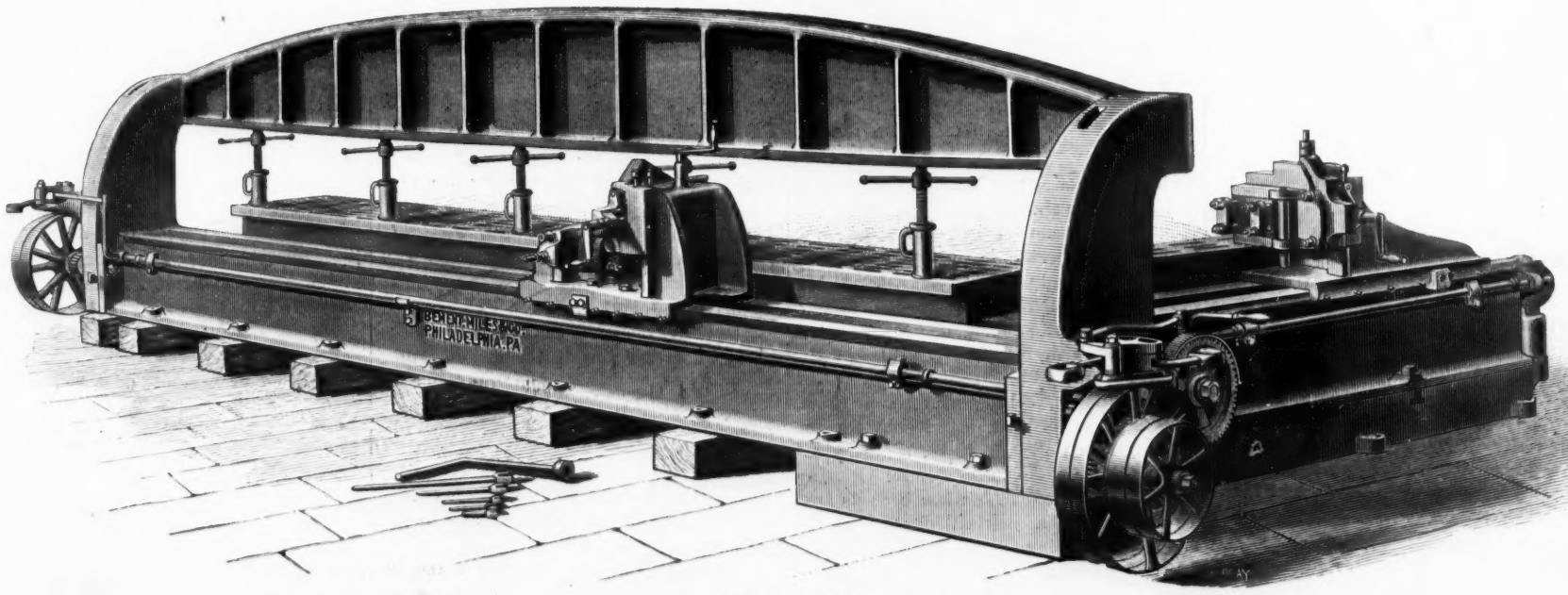


PLATE PLANING MACHINE.

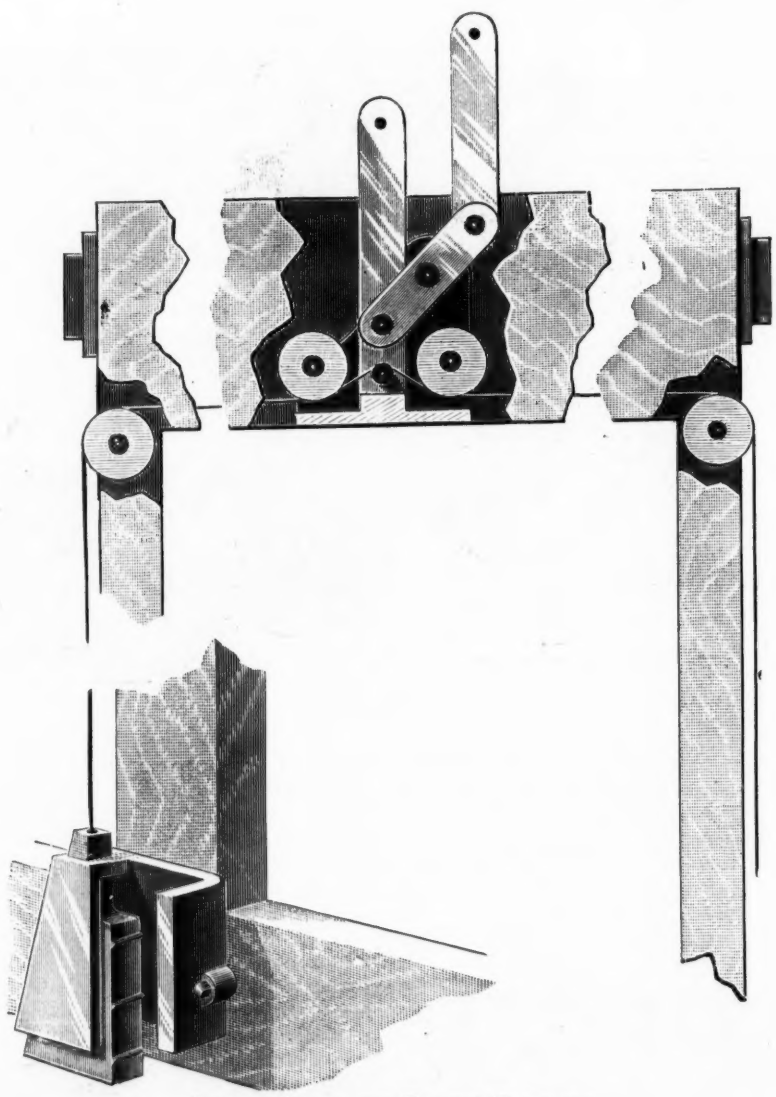
forth between two set collars, which are adjusted to such a point that, when the upper or lower limit of the travel of the car is reached, the moving collar comes in contact with one or the other of the fixed collars, when, being thereby prevented from moving endwise, it turns with the shaft, and in so doing, by means of the short arm shown below the collar, turns the cam plate, which, in turning, throws the lever which is shown extending diagonally across the end of the frame to the sliding bar which throws the driving clutches. This bar is thus moved and the vertical shaft rotated sufficiently to allow the automatic brake, before described, to be applied.

To the cable, just above the point at which it leaves the drum, there is applied a small grooved roller, which, if the cable should become slack from the accidental catching of the car in descending, will fall, and by throwing in a pawl, cause the last mentioned cam plate to revolve by means of the lever, move the shifting bar, releasing the clutch and allowing the application of the automatic brake. Owing to the number of teeth with which the pawl may engage, not more than 4" of slack cable can be paid off before the motion of the machine is arrested.

The friction clutches used for driving, by their prompt and uniform action, enable the car to be stopped very close to any desired position, and do away with the necessity for several trials before getting the exact proper position, as is often necessary, especially when loading or unloading heavy objects at points between the floors. In descending with a heavy load under such circumstances, the clutch can be thrown out when near the desired point, and the automatic brake allowed to act just sufficiently to allow a slow motion by gravity, until the proper point is reached.

The cut on this page shows the safety device, which is used on the car. The hoisting cable is attached to the upper one of the two vertical links seen projecting from the top of the cross-beam, while the cable, which connects the counterweight with the car, is attached to the other link. These two links are connected, as shown, so that, if one rises, the other will be drawn down. Supposing the hoisting cable to break or become disconnected from the link, the car, in descending, must raise the counterweight. The unbalanced pull on this cable draws the link upward, and, by means of the small cable shown, also draws upward two wedges, one of which is shown in the cut, there being another one on the opposite side. These wedges engage with the side rails and stop the car; this action taking place so quickly as to prevent the descent of the car for more than an inch or two, as shown by repeated trials. Thus the car is stopped before it can possibly attain sufficient momentum to do any damage.

The capacity of the machine shown is 5,000 lbs., and they are built up to 12,000 lbs. capacity, by The D. Frisbie Co., 112 Liberty street, New York.



SAFETY DEVICE FOR FRISBIE ELEVATOR.

Shop Notes.

The door leading into the shops of the Straight Line Engine Co. at Syracuse, N. Y., bears the legend in bold letters "Visitors Always Welcome." We found that this was meant to include everybody, even wandering newspaper men, and is in quite distinct contrast to many of the shop-door inscriptions. And yet Prof. Sweet says they are not bothered by visitors. People living in Syracuse, knowing that the shop is entirely free to visitors, do not visit it much, for the same reason, probably, that men do not usually place a very high valuation upon anything which is free to everybody, and can be secured at any time without expense or effort, while people coming from a distance, who are interested in mechanical matters, would be welcomed anyway, on general principles.

Business with the company has been for some time crowding them to their utmost capacity, and it is easy to see that their shops are not as large nor as well arranged as they should be for the volume of business they are doing. This difficulty, however, will probably be remedied soon, as they have in hand plans for a new shop, which will probably be built next season, which, besides being large enough for the business of the company, will embody all the latest features of what has been called shopitecture.

Amongst the work on hand at present are some engines which are to go to Paris, and will be in operation at the Exhibition there next summer. There will be six of them there altogether, three of which will be built here and three in Germany by Heilmann, Ducommun & Steinlen, who are said to be the Brown & Sharpe of that country, and who expect to go into the manufacture of these engines.

One of the three built here will be used to furnish power for the exhibit of J. A. Fay & Co., and one, a new 100 horse-power, to drive one of the lines of shafting in the American Department.

Near the door, as one enters the shop, is the Traversing Machine, designed by Prof. Sweet, which was illustrated and described in our issue of May 26, 1888. It is in constant use on the regular work of the shop, boring connecting rod boxes, milling valve, and steam chest seats, and drilling the holes for the studs at the same setting, milling the guide surfaces, and performing many other operations impossible to do upon any other single machine, and all with the greatest facility and in the best possible manner. At the time of our visit, Mr. F. A. Pratt, of the Pratt & Whitney Co., was there with one of their draftsmen, looking over the machine, with a view of bringing it out for the market, which the P. & W. company expect to do in the near future. It may safely be predicted that, when brought out, it will cause a marked change in the methods of doing work in many shops.

The Straight Line Engine has the cylinder cast solid with the arms which extend from it to the main bearings, and perform the functions of the bed of an ordinary engine. A special machine built in the shop bores the cylinder, and the two bearings for the crank-shaft at the same time, two bars being used, which, being once adjusted exactly at right angles one to the other, and in the same horizontal plane, insure the accurate alignment of the engine, without the trouble of carefully setting each bed twice in the machine. In fact, the alignment of the main bearings with the cylinder does not depend in the least upon the setting of the bed in the machine, but entirely upon the accuracy of the machine itself, which is easily maintained. And, since the bed is held in the machine at three points only, *i. e.*, by the flange at the rear end of the cylinder and by the outside of the main bearings, the lines joining these three points forming a triangle, the bed cannot well be sprung while setting it.

Being a center crank engine, there are two crank disks, which, by means of arms extending from their peripheries to heavy rims, are also fly-wheels as well as crank disks. They are chucked upon the face plate of a lathe, being held by three of the arms only, to prevent springing by the wrench, and at the same time to allow the wheel to spring and take its natural position as the roughing cut is removed from the rim. At the same chucking the disk is faced and the hole for the crank-shaft bored in the usual manner, after which a couple of brackets are bolted to the slide rest of the lathe for boring the crank-pin hole. These consist of A-shaped pieces, having at their upper points, bearings for a boring bar, which extends from one to the other, carrying at one end a pulley for driving it, and at the other end a cutter which bores the crank-pin hole. Upon one wheel of a pair this is the last operation, while upon the other it is the first, the holes in a pair of disks being thus both bored at the same setting of the fixture. With a certain set of blocks under the legs of the A frames, the distance of the bar below the center line of the lathe is set just equal to the crank radius of the largest engine built, and other blocks of the proper thickness placed on top of these bring the bar up towards the center to the proper distance for smaller engines.

Both parts of the crank-shaft and the wrist-pin are pressed into their places, and are found to be amply secured by this pressure, without keys or other fastenings.

After the crank-shaft is thus made up, two cup-shaped pieces are placed over each end of the shaft, which can be shifted about and adjusted by means of set screws which are tapped through their sides and bear upon the shaft. In the center of each of these pieces is a plug, which is centered to run on the lathe centers. The caps being in place over the ends of the shaft, it is placed in the lathe on the centers, and, as it is turned to different positions, a fine and sensitive level is applied to the wrist-pin, which, before being pressed to its place, has been hardened and ground. By means of the set screws the caps, and consequently, of course, the centers upon which the shaft turns, are shifted until the level shows true when applied to the wrist-pin in any position. Then, leaving the caps undisturbed, the plugs are taken out of them and bushings put in, through which the shaft is re-centered, of course, precisely true with the wrist-pin; after which it is put into the lathe upon the new centers, and the light finishing cuts taken over the shaft and rims of the wheels; after which the bearings and pulley seats are ground by an emery wheel while the wheels are rotated on dead centers: a method of procedure which will be recognized as quite ingenious, and quite likely to secure a true wrist-pin and shaft.

In the foundry, the method followed in moulding fly wheels, hand wheels, pulleys, etc., is a novel one, and worthy of notice. Only one-half of such patterns are made, and they are faced off in the lathe down to the center, or what would be the dividing line of the mould; those which are to be used continuously, being made of iron. They are then fastened to the flat surface of an iron plate which extends somewhat beyond them on all sides, and is provided with holes drilled for dowel-pins, and others tapped for screws, the uses of which will be hereafter designated. One-half of the flask is placed on this plate over the pattern, its position being fixed by pins which enter the holes in the plate. After being rammed up, the entire thing is turned over and into three tapped holes before referred to, which are equidistant from each other, and near the outer edge of the plate are screwed three screws, which pass down through the plate and come into contact with the flask in such a manner that, if they continue to be turned, they will lift the plate with the half pattern from the mould. The upper ends of these screws are provided with small cranks, and all three of these cranks are connected together by three strips of wood, which, when in place, form a triangle, so that, when one screw is turned, the other two must turn also, and at the same rate. By turning the screws, the pattern is drawn very steadily and evenly, until it is entirely clear of the mould, when it is lifted off. The same process is repeated for the other half of the mould, except that the pins are put into the holes of the plate instead of the flask. In this way both parts of the mould are made, not only from the same half pattern, but the two surfaces of the mould fit very accurately together, the result being a very superior casting. Of course, the method is applicable only to straight-armed wheels or pulleys, or to those having webs instead of arms. The above are a few only of the methods pursued here which are different from those followed in other shops, time and space forbidding the mention of all of them. Prof. Sweet has himself described some of his methods in our columns, and we shall endeavor to have him continue the practice.

Economy of Steam and Gas Engines.

BY PROF. DEVOLSON WOOD.

The relative economy of the different classes of engines depends upon many circumstances. Gas engines are not used where gas cannot be purchased. One would not consider the purchase of a gas engine, if, at the same time, it would be necessary to purchase a gas plant for the manufacture of gas for running the engine. The purchase of steam by the pound, foot, or horse-power, is not common, although it is done in some cases. It is more common for the owner of an engine to own an entire plant, thus generating the steam used by the engine. The first cost of the gas engine and of the steam plant, of fuel, attendance, and repairs, all enter as

elements in determining the relative economy, so that while one engine may be the more economical under certain circumstances, another will be more economical under other circumstances. It is, therefore, impossible to decide what class of engine one should adopt, without knowing the conditions under which it is to be used. Some general facts may, however, aid one in reaching a proper conclusion.

The best gas engines have developed one horse-power per hour, with about 24 cubic feet of gas. The records of some tests make a better showing than this, the reports showing 20 or 21 cubic feet. But all these cases are the results of special tests, when all the conditions are as favorable as it is possible to make them. The engine is in excellent condition, and the records do not generally begin until after the engine has been run a short time. No allowance is made for the imperfect condition of the engine in ordinary every-day use, nor for the escape of gas not utilized. The man running the engine pays for all the gas passing through the meter, whether it is effectual in producing the power or not. We will therefore assume, as a sufficiently close approximation, that for every-day running a good gas engine demands at least 30 cubic feet of gas per horse-power per hour.

For the sake of easy computation, assume that the gas costs one dollar per thousand feet, or one cent for ten feet, in which case the fuel will cost three cents per horse-power per hour. If the gas costs one hundred and twenty-five cents per 1,000 feet, the fuel would cost 3¾ cents per horse-power per hour.

Now, consider the fuel consumption of a steam plant. The steamship "Ohio" is reported as developing one indicated horse-power per hour with 1.23 pounds of coal. This is exceptionally low—the lowest of any reliable test we have noticed. The engines are triple expansion, condensing, and of several thousand horse-power. The above was the result of a carefully conducted test, and one is not warranted in using so low a coal consumption for any other engines. The steamships "Umbria" and "Etruria" consume about 2.1 pounds of coal per indicated horse-power per hour, and some other good steamships somewhat more; but this figure is too low for small engines.

The pumping engine Brooklyne, while developing 431 horse-power, consumed 3.8 pounds of coal. Rankine finds for some non-condensing engines, using 60 pounds initial pressure, a theoretical value of 5 to 8 pounds of coal.

A Waterman engine, having a 5¼-inch bore and 10-inch stroke, was tested by Mr. Isherwood many years since. Taking the average of several experiments, we find that, when run with an initial pressure of from 15 to 35 pounds, the cut-off being 0.19 in some experiments and 0.83 in others, developing about one horse-power, the steam being saturated and cylinder air-jacketed, while the pipes and jacket were covered with felt; the coal consumption was from 8½ to 13 pounds per indicated horse-power per hour. The experiments were from 30 to 120 hours' long. When it is considered that such experiments are conducted with care—the engine and boiler being in good condition—the firing even—the speed uniform; and, on the other hand, that in daily practice these conditions are not so favorable, and that fuel is wasted at the beginning and ending of a run, it is certain that this engine, if run under similar conditions in an ordinary shop, would consume more coal than in this experiment, and that an average of 12 pounds would not be too much to allow. At the present day, a higher steam pressure would be used in an engine of this size, and greater economy would result; but in the absence of actual experiments it would be unwise to assume a coal consumption of less than 10 pounds per indicated horse-power in developing two or three horse-power. We know that it may be produced with less, but probably it would require more.

If the coal costs $5.00 per ton of 2,000 pounds, and 10 pounds develop the horse-power, the fuel will cost 2½ cents per horse-power per hour. If the gas for our hypothetical gas engine costs 83⅓ cents per 1,000 feet, the cost of fuel for the two engines would be the same, and the purchaser would consider only first cost, repairs, attendance and convenience, to enable him to decide which to purchase. With gas at 166⅔ cents per 1,000 feet, the gas engine would cost twice as much for fuel as the steam plant.

If the engine is to be run only two or three hours at a time, the loss of fuel in getting up steam, and the loss of time of the fireman in the case of the steam plant, may, relatively, be so large as to make the gas engine quite as economical. If, in addition to these conditions, the work is to be done at irregular intervals, convenience combines with economy to make the gas engine the most desirable.

Modern Locomotive Construction.

By J. G. A. Meyer.

EIGHTY-THIRD PAPER.

In many locomotives the side rod brasses are made similar in form to that shown in Figs. 467, 468 (last paper); and in a few instances they are made similar to that shown in Figs. 469, 470. The difference between these two forms is, that one set is provided with caps *e*, as shown in Fig. 470, which are cast to the brasses; the other set is made up of plain brasses, that is to say, they have no caps.

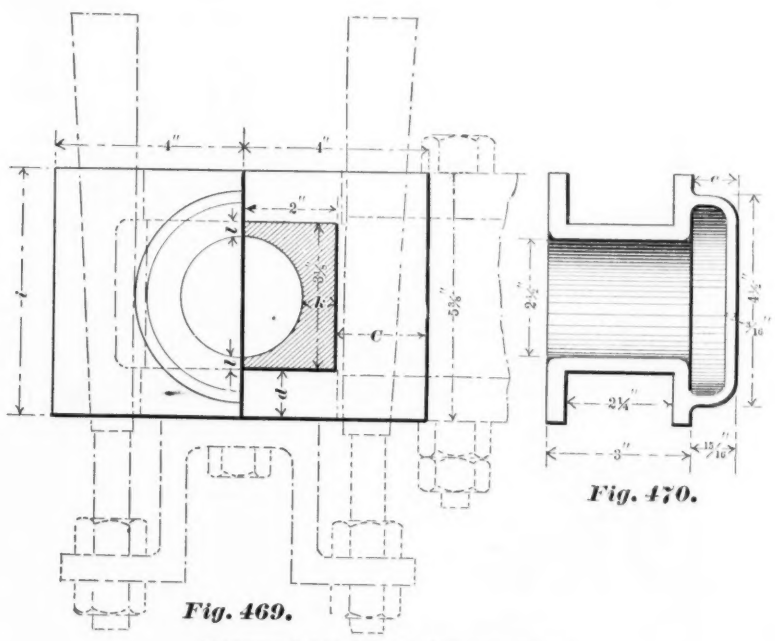


Fig. 469. *Fig. 470.*

Modern Locomotive Construction.

These caps cover the end of the crank-pin; their purpose is to keep the crank-pin, as much as possible, free from dust. The caps answer the purpose for which they have been designed; but they are detrimental to the examination of the condition of the pin which they cover; and consequently they are not as frequently adopted as the ordinary plain brasses.

In Fig. 465 (last paper) it will be noticed that the flanges of the brasses do not extend to the edges of the strap; there are many main rods as well as side rods which have brasses of this design. But there is an objection against the flanges stopping short of the edges of the strap. The brasses are exposed to considerable dust, and, as soon as they become a little loose, the dust will work in between the flanges and strap, and wear ridges in the latter, so that, when it becomes necessary to replace the brasses, the straps must be replaned before the new brasses can be used. Replaning straps should be avoided as much as possible, as such will reduce their strength; consequently we must prevent, as much as possible, unequal wear and the formation of ridges in the sides of the straps. This desired result is obtained, to some extent, by allowing the flanges of the brasses to cover the whole width *i* (Fig. 469) of the strap, and also cover the solid end of the same. Since one brass is a duplicate of the other one, the depth of the flange at *C* appears to be and is excessive; yet, on account of the practical advantages gained by making the flanges so deep, there are, probably, at present more brasses with deep flanges used, than brasses with flanges stopping short of edges of the strap.

The thickness *l* (Fig. 469) of the metal at the joint of the brasses, in main and side rods, is generally about ¼ of an inch.

The thickness *k* of metal between the pin and the butt end of the rods, and also the thickness of the flanges, are given in the following table.

Thickness *k* (Fig. 469) of Metal in Main and Side Rod Brasses.

Diam. of Cylinders.	Thickness of Metal at *k*, Fig. 469.	Thickness of Flanges.
9″	5/8″	3/8″
10″	5/8″	3/8″
11″	3/4″	7/16″
12″	3/4″	7/16″
13″	7/8″	1/2″
14″	7/8″	1/2″
15″	7/8″	9/16″
16″	7/8″	9/16″
17″	1″	5/8″
18″	1″	5/8″
19″	1″	11/16″
20″	1″	11/16″
21″	1 1/8″	3/4″
22″	1 1/8″	3/4″

The length of side rods should be ascertained by actual measurement when the engine is hot. The brasses should have a somewhat loose fit on the crank-pins, so that, when the engine is in working order under steam, the side rods can be moved on the crank-pin to just a perceptible extent.

The following proportions of the different metals for main and side rod brasses we believe will give good satisfaction:

Six pounds of copper, one pound of tin; to one hundred pounds of this mixture add one-half pound of zinc and one-half pound of lead.

Crank-Pins. Crank-pins are either made of steel or of the best quality of hammered iron. In order to reduce the wear on iron crank-pins, they are frequently case-hardened. During the process of case-hardening, the crank-pin will, to some extent, alter its form, and therefore, after case-hardening, it must be trued up. In so doing, the case-hardened surface may be reduced to an uneven thickness, which in time may produce an uneven wear, and interfere with the cool and smooth running of the engine. On the other hand, steel crank-pins do not need to be case-hardened, they wear well without it, and therefore the chances of obtaining a wearing surface of different degrees of hardness are lessened, and the causes of heating and uneven wear are to some extent removed. Yet a wrought-iron pin has an advantage over a steel one; the latter, when subjected to an excessive pressure—which may happen even in the best designed engines—may break or snap off suddenly, and thereby cause considerable damage; on the other hand, a wrought-iron pin will bend to a greater extent before it breaks than a steel one, and consequently may give, in many instances, a timely warning of an excessive pressure, so that repairs or changes can be made before much damage has been done. But steel pins can resist a greater pressure than iron ones, and, since they do not need to be case-hardened, they are often preferred. Hence on some roads we find steel pins used exclusively, and on other roads iron pins adopted. We prefer steel pins.

From the foregoing remarks we infer, and correctly too, that in designing a crank-pin we must keep in view its strength, and also its liability of heating. To prevent heating, we must have a sufficient bearing surface, and, when a sufficient bearing surface has been provided, then the crank-pins, having such proportions as are adopted in modern locomotive practice, will also be strong enough for the work they have to do. Hence, in determining the dimensions of a crank-pin, we shall be guided mostly by the pressure which the crank-pins have to resist. The pressure on the crank-pin is estimated by the pressure on its projected area; that is to say, by the pressure on a rectangular surface, whose length and breadth are equal to the length and diameter of the crank-pin journal; see explanation of projected area, given in connection with crosshead pins, forty-seventh paper.

In comparing the pressure per square inch of projected area of the crank-pins as made by different makers, we find a great difference; indeed, in some instances we find the pressure per square inch on the projected area to be about 1,000 pounds: in other cases the pressure is nearly 2,000 pounds per square inch. The low pressures on crank-pins we find to occur mostly in small engines, and the higher pressures mostly in large engines; which seems to indicate that the crank-pins in a number of small engines are somewhat large, and in a number of large engines the crank-pins are too small. The truth of these conclusions, we believe, is confirmed by experience and the results in practice.

In the rules which are to follow, we shall adopt 1,600 pounds per square inch of projected area of the crank-pin, and determine the size of all crank-pins according to this pressure.

A correspondent writes us that he has hitherto mounted his blue prints on wood, one-half inch thick, but finds them clumsy. He would like some draftsman to suggest a light, cheap and durable substitute. We presume he might object to the cost of good cardboard, but perhaps would find sheet steel or cold rolled sheet iron satisfactory.

In olden times, explosions were as frequent as fires among Western craft, but that danger has disappeared, simply through an increase in the supply of skilled labor. Competent boiler makers and competent engineers are in plenty now, and the boilers no longer explode, because competent men know where the danger line lies, and are not recklessly regardless of it, as their predecessors were.—*Commercial Advertiser.*

Practical Details of Blacksmithing.

By B. F. Spalding.

ECONOMY AT THE SACRIFICE OF STOCK—EXCEPTIONAL CASES—A DRAFT HOOK—FORGING FROM THE SOLID—COHESION OF FIBERS—THE BOLT HEADER—EFFECTS OF UPSETTING IRON—RED-SHORT IRON—BREAKING AT DROP—THE HORIZONTAL BENDER—HORSE SENSE ABOUT BENDING MALLEABLES—TIME AN ELEMENT OF SAFETY.

While it is often the case, in the multiproduction of specific shapes in forging, that the purposes of economy are subserved by the sacrifice of stock, and that it sometimes happens that an article can be produced cheaper at the loss of two ounces of stock than it can at the loss of one, yet the fact will continually obtrude itself upon the expense account, that there is such a thing as sacrificing more than can be retrieved by paying high prices for stock simply to de-

rive the benefit of its good qualities from it in making forgings with facility, when equally good forgings can be made from cheaper material, at an additional expense for labor which is less than that involved in the difference in the cost of stock. The thing to be looked at is the result; the cost per pound of the finished forging is to be considered, in order to determine whether the more expense for stock, or the greater outlay for labor, is consistent with the exercise of economy.

If there should be a piece to make like that shown in Fig. 1, which represents a draft hook, and this piece was anything less than six or eight inches long, it would be within the capacity of a drop-hammer of moderate size to forge it out of the solid bar at the expense of very little labor. It would only be necessary to take a bar of sufficient size, and strike it into such a form, edgewise, as would lay flatwise on a die in such a position that the blows of the drop-hammer, falling upon it, would force it to fill an impression in the die, of the correct size and shape. It must be remembered, however, that the object of making this piece is not for the purpose of having something that is easy to forge, on which to exhibit the powers of the drop. This is not even a minor consideration. The principal object is to produce a piece which may be depended upon to successfully resist any strain which may be put upon it, so that all doubt upon this point being removed, the attention may be directed to strengthening other parts of the machine, until a reasonable certainty shall exist that no part shall fail under any fairly supposable circumstances. It is one of the conditions, that this excellence shall be attained at a minimum of cost. If this hook weighed as much as a pound, it might still be within the limits of economy to use an excellent and expensive quality of iron for the purpose of forging it, by simply striking it up, but for anything beyond this size, it would probably be more economical to put a little more expense in the forging, and take cheaper iron. In the case of a piece like a gun frame, where there is to be much work put upon a forging to finish it, it is prudent to pay for extra good iron, to ensure against losing this work on account of the imperfection of the material.

It is evident that if the hook is struck up out of the solid iron, the fiber of the iron will run very nearly in the direction of the straight shading lines of the cut, across the curve of the hook, instead of around it. The fiber of Norway iron might be coherent enough in this direction to afford sufficient strength, but the fiber of common merchant iron is not generally so closely united as to guarantee that an unprofitable percentage of the number of hooks made from it would not break if put to the test they are required to stand. It then becomes necessary to devise some plan to take advantage of the strongest properties of common iron to make the hook, and the first and most natural way which suggests itself for doing this is to draw the iron down to the right size, and bend the hook so that the fiber shall run around it, in the direction of the curve, the same as if a number of wires were bunched together and then bent into a hook; each wire would conform to the general direction It is very true that, if the wires were not firmly united together, so that they could not move on one another, the hook thus made would not be as strong as it would be if they were so held, because this binding together is the essential part of the bracing principle, which makes stock stiffer by widening it in the direction of the pressure; but no stock which does not open its fibers in forging, allowing them to slide upon each other and show flaws in bending when hot, is likely to be so weakly coherent as to fail from weakness due to this cause after it is cold.

It having been determined that the hook is to be made by bending a straight piece, the next thing to be ascertained is the shape to which this piece should be brought to prepare it for bending. By following this process of retrocession from the last form which the iron is to assume, back to that in which it must appear before the last operation is performed, and this again back to the one which preceded it, we shall finally arrive at the first change which is to be made from the form of the merchant bar, and discover what shall be the dimensions and shape of this bar. By drawing a line on the side of the pattern, not in the center of the hook, but two-fifths of the distance from the inner towards the outer side of the hook, and pointing this line off in spaces say half an inch apart, and measuring perpendicular lines drawn across the hook at these points, and transferring the measures thus obtained to a straight line similarly pointed, a fairly correct figure may be drawn of the appearance which the piece will have before it is crooked. This is shown in Fig. 2.

A part of this form *B* is of uniform size, and one way of making the piece would be to accept this part as the size of stock from which it is to be made, enlarging it for the head *A*, and decreasing it for the smaller part *C*. If there were no machines available for performing these operations, and the job was to be done by hand, the bar would be upset on the end and the head formed with set hammers and swages, and the tail would afterwards be drawn out on the anvil. But in a bolt-heading, or, as it is sometimes called —too indefinitely—a forging machine, the work of forming the head can be done much more expeditiously, the same sequence of operations which would be followed by hand being carried out by the machine; the upsetting, flatting and swaging being done by the various movements of its working parts.

The bar, being cut off to the right length, the piece is seized when hot by the gripping dies of the machine, and held from slipping back by the thrust bolt. The machine is started, and the first blow from the header, going as it does the full extent of its throw at once, drives the end of the bar up to within 1¼″ of the grip dies, as this is the length to which the head is to finish. If the heat is just soft enough, and the end of the bar very nearly square, the stock will be driven back and the piece bulged out on all sides, growing thicker as this part swallows about an inch of the bar, as shown in Fig. 3. But whether the stock upsets, or dodges and bends, the plunger will cause it to occupy this limited space, and if it is not upset it gets badly crippled, appearing sometimes as shown in side view by Fig. 4.

The side hammers now strike and flat it out, when it will have the appearance shown in Fig. 5, and the other hammers impress their shape upon it as much as possible, as shown in Fig. 6 with the result of marking it on the sides with the part of the dies which should form the end of the piece, but which now strike at a distance from the end, on account of the ill-behavior of the stock; and although, by the continued action of the machine, the head is shortly brought to its proper form, it still hides the imperfections, which have not ceased to exist.

The process of upsetting always loosens the tenacity with which the fibers of iron are held together, and only that which has had the slag thoroughly worked out will resist the strain which tends to force them apart. This tendency should always be corrected by side compression at a welding heat. Bolts are thus made by the machines with great success, as are also many other things, but, as has been shown, these pieces do not get the benefit of the side compression at a welding heat in every case, and, as they are subject to a further strain in punching the three holes in the head, it seems advisable to take stock large enough to make the head without upsetting, and reduce it to whatever extent may be necessary to make the rest of the piece. The size of the head being given as 2½″ × ½″, a shape conforming to those figures might be used; but 2″ × ⅝″ is preferred, as it is a more convenient shape to draw down, and measures the same in cross-section. With a piece of a bar of this size cut off to the right length, the first operation of making the head can be performed with suitable dies, either at the trip-hammer or drop. The stock is struck alternately flatwise and edgewise with dies, which are cut out to the shape required, until they have brought it to assume this shape, which is represented in Fig. 7. The head is here shown blocked out, and the remaining stock well disposed for taking a welding heat, in order to perform the next operation of drawing out the rest of the piece. This operation is readily done, either with the trip-hammer, or with segmental rolls. With dies containing the impressions for the purpose, the pieces are drawn into the shape shown in Fig. 2, and are then ready to be bent.

They have sometimes been bent at the drop at two blows, the first taking them to the dotted line Fig. 1, and the next carrying them on around to place; but the process is rather too sudden to suit well with the red shortness of much of the common iron. They have been found to bend better, and with much less loss, on the horizontal bending machine.

There is some iron which no amount of gentle treatment can induce to be tractable when it is red hot, and it is bad policy to use it for anything which must be submitted, while hot, to a strain tending to break it, although it may be passibly good for some purposes when cold. Iron of a low grade is here alluded to, but some of a high grade may be included. The first revolver frames made in this country, which had the barrels solid with the frames, were made of an iron which finished like steel, with an appearance of perfect homogeneity, but which was easily ruptured at a low red heat. Such iron needs to be treated much the same as one of our famous inventors said it was necessary to treat malleable castings. "You don't want to go at them sorter rough, and abuse them," he said, "but you kinder want to coax them up—same as you'd lead a horse to water." The bending machine can be speeded to give the iron all the time that is necessary to arrange its particles comfortably in the new positions assigned to them, and on this machine they can be bent with accuracy and dispatch. They are then dropped in a die which fits them snugly without throwing out a fin, and pins in these dies open out the holes nearly through, leaving but a little in the centers, which is punched out at the punch press after they are cold. Even the hole in the point is punched through, making a ¼″ hole through stock half an inch thick. This is for the rivet to the safety link, and when that is put in and riveted, the mechanical work on the hook is completed.

The work has cost more than it would if the piece had been dropped "out of the solid," but the whole cost of the hook is less than half what it would have been to have made it in that way, from iron that would have been sufficiently strong.

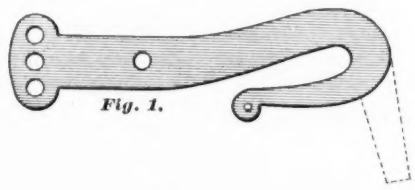


Fig. 1.

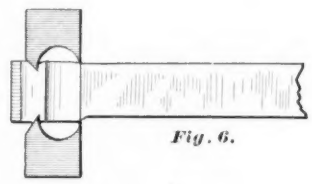


Fig. 6.

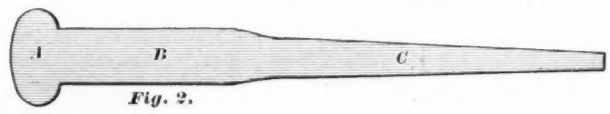


Fig. 2.

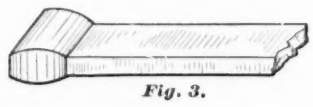


Fig. 3.

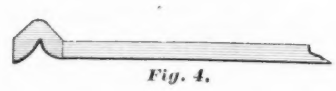


Fig. 4.

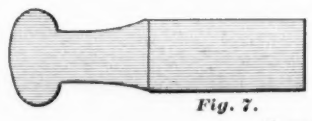


Fig. 7.

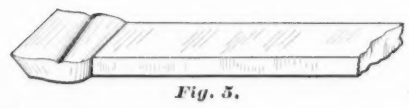


Fig. 5.

DETAILS OF BLACKSMITHING.

Self-Instruction for Young Mechanics.

BY FRANK RICHARDS.

III.

But you may say, if the young mechanic's time and his opportunities are so limited, why shouldn't he spread out and try to embrace as wide a sweep of knowledge as possible, instead of concentrating his energies upon one thing at a time? Well, I suppose it is only natural to try it in that way first. It has certainly been tried often enough, and has always been found to fail. One who thinks he hasn't time to master a subject thoroughly, will talk about "skimming" it, as though he would in that way get the cream, the essence, the richness of it. That may be what is meant by the term, but what we usually get is only a soiled and empty skimmer, that has gathered and retained nothing. Suppose that a farmer had a small amount of seed, and, in the hope of getting as large a return as possible, he spread it thinly over a great expanse of land. The crop would be so scattered, and so choked with weeds, that it would not pay for the gathering. But, if he plant it as close as the ability of the soil to support it will permit, he gets a return for his labors that rewards him well

You may think that thoroughness does not pay, because, after all, thoroughness is not thorough enough. Go through a demonstration in geometry as accurately as you may to-day, and a year from now you can't stand up like a schoolboy and go through it again correctly, and so your labor is all lost. That is no proof that it is all lost, because you are not learning it for the purpose of reproducing it in that way. And even the fact that you can't recall it is no proof that you have lost it. We carry so much of our knowledge unconsciously. There is only a little of our cargo in sight. We don't know what we know. Shut up alone, and required to write out all our accumulated stock of knowledge in all fields, we couldn't reproduce a tenth of it; but when the occasion naturally arises for its application, each item comes to us spontaneously.

Science is the great labor-saver. By the classification and condensation of knowledge which it accomplishes, all things are strung together, or bundled up, so that they can be readily found and got hold of; but it is necessary that we have the string unbroken or the bundle intact. To gather our knowledge in isolated facts, and to pitch them into our memories haphazard, is as good as losing them almost as fast as we dump them in. Most of the pretentious "compendiums of universal knowledge," the glory of the everlasting book peddler, are monumental humbugs. Every one must know the kind of books that I mean, and they must also know that I do not mean the invaluable "pocket-books," such as Trautwine's or Haswell's.

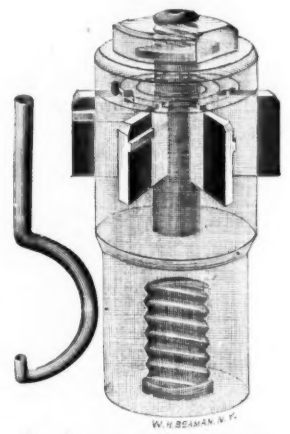
There is another way of learning geometry than by the system of logical demonstration usually followed in the schools. The way that I refer to is similar to the way by which the mechanic is unconsciously led to learn geometry in the work of the practical shop. So far as this system is embodied in any text-book, I find it in a little book, a very little book, written by the father of Herbert Spencer, and published by the Appletons, N. Y. "Inventional Geometry," which is the name of the book, and the price 45 cents, is quite a pet of mine, and I have recommended it to a number of my personal acquaintances, and many of them have got good from it. This

little book, as I said, goes at it in just the reverse way from the stiff and formal old geometry. Instead of presenting a course of logical reasoning, leading to conclusions that are incontrovertible, it offers a series of problems which the learner must discover the means of solving by the exercise of his own ingenuity. The successive problems are so arranged and graduated, and lead so easily onward from one to another, that, while rapid and substantial progress is made, no insurmountable steps are encountered. There is no solution of any problem volunteered, and there is no key to the book published, so that the student is placed where nature places him as a learner of such things. It is scarcely necessary to say that, by following this system, the learner surely remembers what he learns. We can say, also, that he learns much more than he sets out to learn. Like all inventors, he finds different ways of doing the same thing, and he is led to trace the relations of things apparently wide apart.

The student makes drawings of the problems as he goes along, showing his methods of solution, and by the time that he has finished the course he has also advanced far in a preliminary or elementary course of mechanical drawing. This system of learning geometry seems to me well adapted for self-instruction, and especially for young mechanics. The system would only be suitable for class use, when the one who first accomplished the solution of a problem could be required to conceal his method until the others also had succeeded.

This little book also tells the learner to make sketches of the regular solids and other figures that occur in its course. This leads him a little way in another profitable direction, that of free-hand drawing. It seems to me that this subject does not get its due share of attention. While the technical papers and all interested in mechanical education are always talking up mechanical drawing so much—and none too much—it would still be well if they would give more attention to the promotion of free-hand drawing. Generally speaking, it ought not to be necessary to tell a young man in the shop of the value, of the imperative necessity, of mechanical drawing, if he wants to get along in the trade. I believe that, if he doesn't see it, there is not much hope for him. The value of free-hand drawing is not perhaps so obvious, and I may do some one some good by stirring it up a little. One thing that might naturally lead the young mechanic to think less of it is the fact that he sees fewer specimens of it around the shop. The ability to sketch in any ready and decent way, that is, in a way that will show clearly and readily to some one else anything that we want to show them, that ability is rare. It is much rarer than the ability to make a correct working mechanical drawing. Still, it is a great help to any one that wants to get along, and should have an early and prominent place in any course of self-instruction. It is an art of expression, a way of communicating our ideas, and all should realize the value of it. It is necessary to be able to impart what we acquire. Of all that you may have in your head, that only is of any value to me that you can communicate to me. That is all that I know of your stock of ideas, and I must measure you by that. If you do not make a good display of your goods in your front windows, it is foolish of you, and you will have to stand the loss. A "gift of gab," perhaps, sometimes shoves a man along beyond his deserts, and we fellows who are slow and hesitating of speech may not like it, but that is no reason why we should deny it. What we might call gab of the fingers helps a man along in the same way. A ready tongue and a ready pencil count more with the world than personal attributes that we would consider more valuable. The world's estimate of things is apt to be near right in the long run. Free-hand drawing is of personal value in the same way that the other means of expression are; it helps to clear and define and establish our ideas.

It is not so easy to say what course is absolutely best for the cultivation of free-hand drawing. You can't lay down stiff and formal rules, as you can with mechanical drawing. A good series of examples would be valuable, and the best examples would be the actual work of an expert, sketches not made for formal drawing copies, but the natural work of his every-day life. Constant practice under honest criticism can alone secure facility. One should always criticise himself unsparingly. Improvement and progress must always end when one is thoroughly satisfied with himself, and when that condition is approaching, it is time for him to begin to look outside and compare himself and his work with the world's standards. A good instructor can help more in drawing than in some other lines, because what is done is never either absolutely right or absolutely wrong, as in mathematics, but may be



AN ADJUSTABLE REAMER.

of all possible shades of goodness or badness, and the best is open to suggestions of improvement.

If one has any natural bent or talent in this direction, it of course will count for something, but practice is still the one thing most necessary to all. If you have a fine job of machine work to do, you would naturally like a nice lathe and good tools to do it with; but if you haven't the best lathe do the best with what you have. The finest of machine work has been done often without the finest tools, and the best work of the world in all departments is mostly done by those who have no special natural gifts.

An Adjustable Reamer.

The accompanying cut gives a general idea of an adjustable reamer, made by Cranston & Co., 57 Park street, New York city. It is constructed upon the same general plan as an ordinary scroll chuck, the reaming cutters (4 to 6 in number, according to size,) being expanded and contracted to the desired size by turning a collar which is at the end of the reamer, the inner face of which is provided with a scroll thread which engages small projections upon the ends of the cutters. The collar is held in place by a small nut, which, when tightened, gives it just sufficient room to work freely, and when the cutters are adjusted, the larger nut shown is tightened, binding all the parts rigidly together and relieving the working parts of all strain.

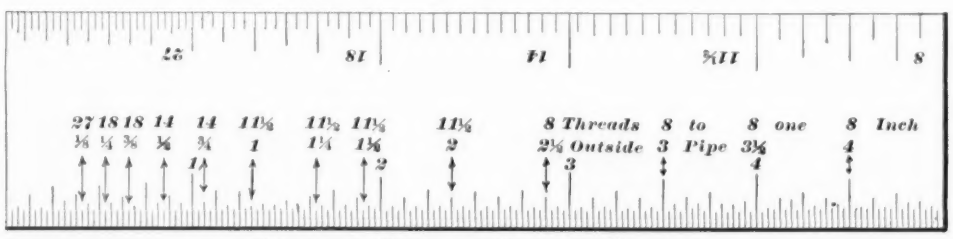
The reamer was invented to meet a want found in the shop where it is made, and is intended not only to enable the reamer to be kept to standard size, but to afford a ready means of reaming holes which are not of standard size, and of restoring the reamer to standard afterward. This can be done by means of a standard collar to which it may be set. They can be used in the lathe or boring mill, and are made in five sizes, enabling any size hole to be reamed from $1\frac{5}{16}''$ to $4\frac{1}{4}''$. They have been used in the shops of Cranston & Co. on general machine and jobbing work for the past two years, giving entire satisfaction.

Scale for Measuring Pipe and Fittings.

Steam fitters and others who are continually working with steam pipes and fittings, soon become so familiar with them that they know at once when they see a piece of pipe or a fitting, what its nominal size is, and how many threads it has per inch. But the nominal size does not at all agree with the actual size, and, as every mechanic knows, a person whose business requires him to only occasionally have to do with pipe and fittings, is often at a loss to know just what the nominal diameter of a piece may be; and the only way he can determine with certainty is by measuring the outside of the pipe or the inside of the fitting, and then consulting a table of sizes for the nominal size corresponding to the measurement. Draftsmen as well as others often experience some trouble with this matter, in making drawings in which pipes and fittings of various sizes must appear, and upon the actual diameter of which other parts of the drawing depend. Then, too, since the number of threads per inch on such work varies arbitrarily on the different size pipes, from 8 per inch to 27, it is not easy to remember the proper number for all the different sizes, unless the work which one is engaged in requires constant reference to it. The accompanying engraving represents a scale intended to obviate these difficulties. It is the invention of a draftsman, who, in his every-day work, had found the need of such a scale. The cut shows a scale, 5″ in length, which is, perhaps, the best length, though, of course, it can be of any length desired. As shown, the lower edge is divided into inches and thirty-seconds of an inch, the inch marks being indicated by numbers in the usual manner. Above certain ones of these divisions there are marks having arrow-heads, as shown, which connect the divisions with the lower one of the two rows of figures. The figures in this row indicate the nominal diameter of the pipe or fitting. Supposing, for instance, the scale to be applied to a pipe which measures outside $\frac{13}{32}''$, the scale indicates at once that it is $\frac{1}{8}''$ pipe. If it measures $1\frac{1}{16}''$, it is $\frac{3}{4}''$ pipe; if $2\frac{3}{8}''$, it is $2''$ pipe, and so on; and since the graduation indicated by the given line is to the nearest thirty-second of of an inch, the greatest possible variation in the measurement will be one sixty-fourth, which is less than the actual variations usually found in pipe and fittings. This scale may also be referred to when it is desired to know what the actual outside diameter of any given pipe will be, and may be used by the draftsman for that purpose, instead of measuring the pipe or referring to a table of sizes. Thus it is seen at once that a 3″ pipe is $3\frac{1}{2}''$ outside diameter, and that a $1\frac{1}{8}''$ pipe is $1\frac{29}{32}''$ outside diameter.

The figures just above those indicating the sizes show the number of threads per inch on the given size of pipe, and the upper edge of scale has its inch spaces divided into the corresponding number of divisions, enabling the pitch of the threads to be measured or laid off on a drawing directly from the scale.

The scale may be of steel, and made in the style of the common steel rule used by machinists, and may have upon the opposite side other graduations, either plain or for some other special purpose; or it may be of box-wood, and made with special reference to the needs of draftsmen. The inventor is Mr. Walter L. Cheney, Hartford, Ct.



SCALE FOR MEASURING PIPE AND FITTINGS.

LETTERS FROM PRACTICAL MEN.

"Occupation for Convict Labor."

Editor American Machinist:

Seeing a short article in your issue of Dec. 27, under the above heading, the article being partly from C. E. Chittenden, and partly editorial, I beg leave to differ from the views expressed. I am a constant reader of your paper, and give you credit for fairness in the discussion of all questions.

The stand I take is this: Convict labor that is productive to individuals or corporations, has its effect on the markets of the country, no matter how small or how large the industry to which it is applied may be. Its influence is debasing, because it is brought into direct competition with free, honest labor; it tends to bring honest workingmen to the level of the convict.

I judge by surroundings. I am a machinist, working every day for the support of my family in the great and glorious State of Texas. There are two penitentiaries in the State, both having machine shops operated by convicts. Work that is beyond the caliber of the convicts is brought to the shop where I am, but two out of three customers who come here will quote prison prices; prices at which no free man can live. These are facts that there is no getting around, and the consequence is that the firm I am employed by are not employing more than one-third the hands they would employ, but for prison competition.

The State Government is to blame. Why does it not put the convicts at work on the roads, and make them what they should be—an honor to the State? It would take them all time to come to put them in as good condition as I am told they are in Europe.

This, I should think, would be the least hurtful of all ways of employing convict labor; the least hurtful to free labor, I mean.

Palestine, Texas. F. A. LELAURIN.

Getting up Lathe Ways Fifty Years Ago—Scrap Bolts.

Editor American Machinist:

I was looking at a new shaper the other day, and while admiring some of its good points, and trying to find some bad ones, if possible, an old gentleman strolled in, and in the course of a subsequent conversation related to me an experience he had at a time when shapers and planers were as little heard of in some parts of the country as a defeated candidate now is after election. A fire having destroyed the shop and contents where he had been employed, another building was secured, and the work of getting up another equipment of tools commenced, and continued with all possible speed.

Now, in the year 1831 a large number of the lathes had wooden ways, faced with iron plates for the tail stock and rest to slide on. To get a true surface on the plates after they were firmly bolted to the wood, required a liberal expenditure of muscle applied to the hammer, chisel and file. In order to avoid the foregoing, my friend devised the following: He selected two suitable pieces of wood, and, after truing them up on all sides, bolted them together with blocks at each end where the bolts passed through, so as to leave a narrow space between the timbers. The plates were next fastened in place and a frame made, which was free to slide on the timbers. From his description, the frame must have resembled the modern slide rest somewhat. To this sliding frame or rest was attached a tool which could be moved at a right angle to the ways or bed of the lathe by means of a screw.

Sliding the frame back and forth on the ways was accomplished in a rather simple manner; a rope was fastened to the frame and passed around a vertical shaft, which slowly revolved, and by pulling on the free end of the rope sufficient friction was obtained to cause the rope to wind around the shaft, and consequently pull the frame which carried the cutting tool from one end of the bed to the other, and at the same time take a cut over the iron plate; when the tool

arrived at the end of the cut, the rope was slackened and the frame pushed back by hand, the tool moved over, and the operation repeated until the iron plates were both gone over, when, he assured me, they presented a very creditable appearance.

More than half a century has passed since my friend made use of the foregoing device, and in that time vast and important improvements have been made in nearly all branches of mechanics. But I think he would say (if he had my opportunities) that there has been no particular change in the condition of the bolts, nuts, washers and clamps used around some shops, except that they are worse to-day. In some shops I see them scattered over the floor near the lathes and planers, in others a box is used to receive all sorts and conditions of bolts and nuts. Those of us who have wrestled with a job requiring several bolts to hold it on the face plate of a lathe or on a planer bed, know that it was with a feeling of dread that we began our search for the required bolts, even in the shop where they had a bolt box. As we went through the collection, our features would sometimes light up when we found a bolt of the exact length, but a closer examination would often reveal the fact that the end was bruised up so that it would be impossible to get a nut on without re-threading it. Then there would be the bolts with stripped threads, and the old carriage bolt; the hook bolts that had a crack in them; the bolts with odd pitches of thread, together with the assortment of bolts of every kind which the scrap heap fiend gathers from time to time and puts in the box, remarking to himself (as Mrs. Toodles would say), "We don't want them now, but if ever we do, how handy it will be to have them in the shop."

I never could see any reason why this collection should be so religiously guarded and preserved, but I never have worked in a shop where this state of affairs existed, that anyone had the courage to clean out all the useless bolts and keep nothing but good ones with standard threads. Someone has to pay for the time required to hunt up bolts in a shop where no attention is given to the matter. If such is the case in your shop, it is not too late in the year to remedy it.

F. H. TREACY.

Heavy vs. Light Reciprocating Parts of Steam Engines.

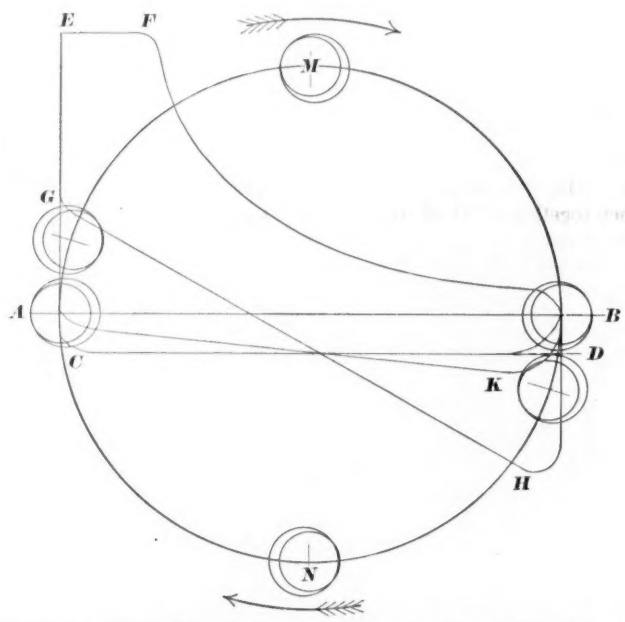
Editor American Machinist:

A series of papers now running in the AMERICAN MACHINIST, entitled "Force in the Steam Engine and its Relation to Smooth Running," have in them so much good reasoning leading to false conclusions that I am tempted to endeavor to point out the error. The eighth paper appears to be devoted to proving that heavy reciprocating parts are a necessity to smooth running in a quick-speed engine, and that there is no loss of power in their employment. Professor Torrey appears to follow closely the lines of argument put forth many years ago by Mr. Porter, by means of which he convinced himself that his was the true system, notwithstanding certain ugly facts in the shape of hot crank-pins and thumping centers.

The accompanying diagram I have taken from one of Mr. Porter's books. In describing this figure he says, "The indicator diagram *C E F B D* shows how excessively unequal the pressures applied to the crank would be, if the reciprocating parts were without weight." This is true, and it is also true that this inequality of the pressure is the very thing needed to cause the engine to run quietly. I have drawn the circle *M N* to represent the path of the crank-pin; the small circles represent the pin at different points. The small circle *A* shows the crank on the center, and the eccentric circle shows the inside of the brass, which is in position ready for the steam pressure *E* to come upon it. At *M*, the half revolution, this thrust continues, and so on up to near the end of the stroke. We must now arrest gently the motion of the piston, and this we have done in two ways: First, by expanding and exhausting the steam; second, by a very moderate compression.

The brass is now in contact with the pin, as at *B*, and no jar can result, however great the initial pressure may be for the return stroke.

Mr. Porter then draws the diagonal line "*L K*, showing in how slight a degree this inequality is corrected in the best ordinary practice." That is, light reciprocating parts, or slow motion, or both. Then the line "*G H*, showing the result obtained by increasing the inertia of the reciprocating parts in a judicious manner."



HEAVY VS. LIGHT RECIPROCATING PARTS OF STEAM ENGINES.

Here we have the piston arriving near the end of its stroke, with a pressure equal to about half the initial pressure. We can only arrest the motion either by the crank-pin, and the pressure remains on until the center is passed, as shown at circles *K*, in which case the bearings are prepared to give a big thump when the steam is applied, or we can produce an excessive compression, which makes the area of the card and the indicated power less.

This latter method may, if the foundations are heavy and the engine stout, conceal, for a time, the vicious action of those heavy reciprocating parts, but put it on board ship, where the foundation is elastic, and everything as weak as we dare make it, and I think the strongest advocate of heavy reciprocating parts will want to go ashore without stopping to argue further.

In regard to the action of the heavy reciprocating parts at the commencement of the stroke—if the crank-pin and box are in the position shown at *A*, the lost motion is already taken up, and there is no thump, whether the parts are heavy or light.

If the pin and box are as shown at *G*, with the bearing the wrong way, in consequence of insufficient compression, then the thump will be just as great with heavy parts as with light. For, although the motion of the heavy parts may be slower than that of the light parts, the products of the weights by the squares of the velocities will be equal, hence the energies of the blows will be equal, being produced by equal steam pressures acting upon unequal weights.

There has been a great deal said in favor of equalizing the pressure upon the crank-pin, but an equal pressure upon the crank-pin, even if it were desirable for other reasons, does not imply an equal turning effort for the crank, and, so far as reducing the liability of the pin to heating, there can be nothing in that; for, with equal development of work per revolution there will be an equal development of heat per revolution to be carried away by conduction or radiation.

In practice, heavy reciprocating parts in a quick-speed engine, whether incorporated with a design as a part of the theory of the engine, or as a necessity arising from some economical method of construction, have always given trouble to somebody. Some of the vertical single-acting engines come down like a steam hammer for all they are worth, and nothing but a steam hammer foundation will stand up under them; when they go up, they require a great compression to stop them. One of these engines I have seen fitted with an air-compressing cylinder and piston.

In a horizontal engine great compression is necessary at both ends of the stroke, reducing the indicated power, and if the steam be condensed and a good vacuum line obtained, it is impossible to obtain quiet running, as there cannot be sufficient compression to retard properly the motion of the piston.

In a horizontal engine, whether non-condensing or condensing, the heavy reciprocating parts being brought to rest by compression of steam between the piston and cylinder head, or by the action of the crank-pin, a horizontal swaying is produced, which no foundation can resist. A counterbalance is then put in, which makes the engine appear to stand better so long as it is on a firm foundation, as the vibration then becomes vertical, and is better resisted. But let that engine be a locomotive, and you will very soon have the bridge men after you for shaking down their structures, which are none too good for a steady load.

Moral—make your reciprocating parts as light as you can, and you save yourself and your friends a world of trouble.

WILLIAM H. HARRISON.

Braintree, Mass.

Finishing Steel Journals.

Editor American Machinist:

In answer to the query of H. B. Harrison as to finishing steel journals, I would say: It is not good to have a file or emery finish on any journal, or on any frictional parts whatever; the uneven motion and strain in filing naturally makes a surface untrue, and out of round, especially in lathe work. Again, it is better not to use emery on any working parts where it can be avoided, as small atoms of emery dust are apt to become embedded in the work, and in time will probably cause cutting or heating, and make trouble. But in cases where hardened surfaces are to be finished, grinding or lapping is an only resort. I think all wearing parts ought to be finished with cutting tools in the machine. I would recommend H. B. H. to use a broad-faced, fine-edged tool, with a little oil and water, and make a perfect finish, true to its center, leaving a smooth, clean face, which will give best satisfaction.

TOM DOVER.

Pane or Pene.

Editor American Machinist:

Referring to your answer to Question No. 1, in Jan. 3 issue, you will find the word "pane" defined in Webster as "the narrow edge of a hammer head." This spelling is also used by Spon in their publications. You probably overlooked the word in Webster. I, like yourself, prefer the word "pene," but the other seems to have the greater authority.

C. H. MARVIN.

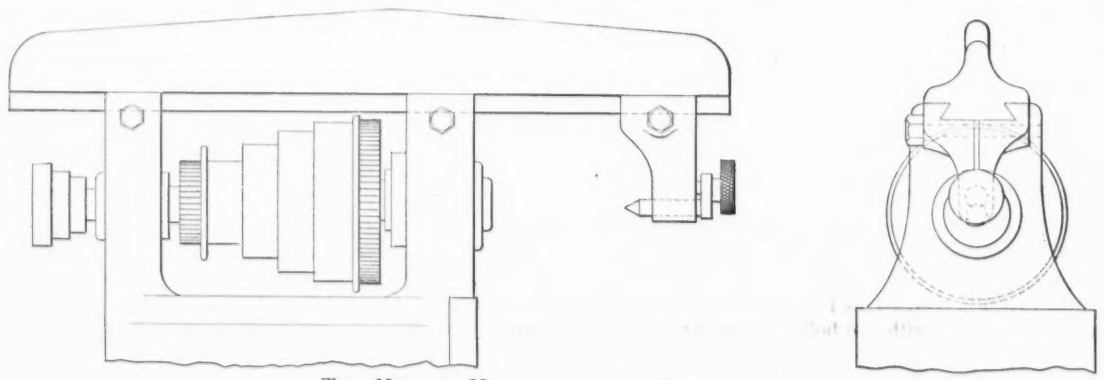
Personal.

Albert Spies, M. E., who has for more than seven years occupied the position of mechanical editor of the *Iron Age*, has resigned his position for the purpose of taking up professional work. Mr. Spies' connection with newspaper work will undoubtedly be of advantage to him in the field of mechanical engineering.

The Milling Machine and its Operations.

BY A. B. LANDIS.

Much has already been written on the subject of milling machines; but, as that machine stands pre-eminent in manufacture—as all who are acquainted with its operations, well know—too much cannot well be written about its uses, and in defining the many operations to which it is adapted; also, in pointing out improvements on milling machines now extant, by which work can be more speedily and accurately done, as well as in showing up improvised means of doing different kinds of work, which often appear difficult and perhaps impossible to do on most machines now on the market. The Universal Milling Machine would seem to meet all these conditions—as its name would imply—but this is not always the case. In these articles I would propose to give my views on the milling machine, together with my experience on the same; to show wherein I think improvements are necessary, and my experience without them; also, special fixtures I applied for doing work that the machines without were not able to accomplish.



THE MILLING MACHINE AND ITS OPERATIONS.

In this article I will show a machine having an overhanging supporting arm, which certainly is the best form of machine for universal milling, in that it is more accessible to the work when the outer support is not needed, since it can readily be removed, whereas in machines otherwise made, this support is a fixture. I believe all overhanging supporting arms are made round where the outer center head slips over (at least they are to my knowledge), and they are no doubt so made because cheaper to manufacture; at least, I can see no other reason, as they present no advantages, except, perhaps, that the center can be turned up out of the way, when want-

ing to remove the milling arbor from the spindle of the machine. But the head can easily be removed for this purpose. My objection to the round supporting arm is that, should the milling arbor be out of truth—owing to imperfection in the series of washers or collars, which generally are used on them, or accidental dirt between them, or otherwise be out of truth—which would cause the outer end of the arbor to run slightly eccentric—and if these conditions exist to the right or left, when applying the center and securing it, the arbor will not hold a right angle position to the traverse of the platens. Consequently in doing straddle milling, the one cutter will be cutting on both sides of the arbor, while the other will cut only on the upward cut. This will make very unsatisfactory work, not making the sides of the work parallel in a vertical line.

Again, in using the arbor in this condition in slitting with a thin saw, the saw will lead off and make bad work, as well as in most cases break the saw.

A few years ago I had a case of very deep straddle milling, and this difficulty was so great as to spoil any job attempted. I at once concluded that the manufacturers of the machine had made the blunder of not making a true machine. But, before holding this against them, I set to work and made a test of the matter, by chucking a plate of large diameter in the arbor, the same as a mill, close to the spindle of the machine. I removed the outer center, clamped a lathe tool in the vise of the machine, and faced off a narrow edge on the outside at the periphery, then, with a square held against a clamped piece on the platen, I made the edge of the square meet the one edge of the plate and clamped a piece at a certain point; then I traversed the platen to the other side of the arbor, squaring from the same point. It coincided exactly with the other edge of the plate, showing the machine to be correct in that particular, the fault lying all in the arbor. I remedied the trouble, after finding the arbor out of truth, by marking the arbor on the side that it was out, and by using great care to have this mark exactly up or down, and the center head free, moving on the supporting arm, carefully getting into place before fastening the head, then adjusting the center. The work then came out right; but this required pains and time. For ordinary surface milling this gives no trouble. The argument produced against this trouble will no doubt be: have your arbor correct. That is good, but, unfortunately, the means are not always at command to have it so, and perhaps the time as well. Perhaps we have careless workmen, and ordinary wear and tear will sometimes bring about these conditions.

We will suppose, though, that we always have a true arbor. Are we sure the conditions for doing good work—of the kind named—will always exist with the use of a round supporting arm? Suppose we are cutting a slot or doing straddle milling of tolerable heavy character, and the operation, owing to size of piece, necessitates the cutters being placed near the end of the arbor? Are we sure that in heavy cutting it will not cause the center head to slip around on the arm, and thus produce perhaps a worse condition than the one before cited? It is a likely thing to happen, since the resistance of cutting is met with the center in a line most favorable to cause the head to slip. What would we think of a turning lathe with its tail center mounted on a round support, without even a key to prevent its getting out of line? We would no doubt call it an absurdity.

True, the case of the milling machine is a little different, since we depend on the arbor to bring the center in line; but, unless it is true, we will—without taking great care—fail. A key used in the arm would, in time, be uncertain.

My plan to remedy the difficulty is shown in the illustration herewith, in which, instead of using a round supporting arm, clamped on top of the bearing of the spindle (as in most cases), I would use an arm made T-shape, as shown, very heavy, even more so than shown, having a regular shear throughout its length, over which I slip the center head, which is split and clamped to the shear with a bolt. The other end of arm would be fastened in a similar guide on the top of bearings of the machine, by any of the many devices in use for that purpose. By loosening the arm on top of bearing, the supporting arm can be made to overhang as much as desired, and when wanted entirely out of the way, which is often the case in doing face work (pretty high), by sliding off the center head the arm can be slid back, entirely out of the way. I know of but one machine in which this can be done, but that has the round arm. Others are made to pivot on the top of the front bearing, but this throws the arm crosswise of the machine, and interferes with free access to the work, when working on face of work, as it is often necessary to be on that side.

For others, again, it is necessary to call at least three men together to lift off the arm, and then again to put it on. This, it will be apparent, is inconvenient and expensive. The latter kind is what I have been connected with, and several years ago I applied a simple thing to overcome that necessity, which I will briefly describe. The rear end of the arm had a round edge at the flat surface where it bolted on. (To be more clear, I will say it was a Brown & Sharpe machine, so as to enable those having one of them to perhaps better see my application.) I made a small casting to fit this round edge, and against the body of the machine, and of a width equal to that of the arm. This I bolted to the body of the machine with two bolts. Now, removing the bolts holding the arm, I raise the arm, and with a suspended rod from above the machine, having a loop at its lower end, I slip it over the arm, and it is held up out of the way, the plate forming a sort of hinge and preventing slipping. The suspended rod should angle back sufficient to insure the loop from slipping off the arm. This is a simple device, easily applied, and time and labor saving.

But to return to the arm as here illustrated, it will be plain that the conditions, as before named, cannot exist as in the round arm, provided it is correctly fitted up in the first place, and should the arbor be out of truth, the three bearing points being in accurate alignment and at right angle with the traverse of platen, it must of necessity make correct work.

Making Corliss Engine Cylinder Patterns.

BY P. S. DINGEY.

SECOND PAPER.

It will scarcely be necessary to enter into the minor details of making the core-boxes, seeing that I have shown herewith both cores and core-boxes for the steam and exhaust sides of cylinder.

I have also assumed that those who read these articles are pattern makers, who understand drawings, and, therefore, will not need every small detail. However, a few explanations may be necessary. Figs. 10, 11, 12, are three views of the core for steam passage and valve chambers, made in one core. A half core-box is all that is needed to make this core, the joint of it being on line C' D' Fig. 10, and the joint of core-box on line E' F', Fig. 12.

Figs. 15, 16, 17, are three views of the core for exhaust passage and valve chambers, also made in one core and with a half core-box.

The core-box for the steam core is constructed as shown in Figs. 13, 14. The port cores e' f' in Fig. 12 are made separate, and pasted in; the core prints to receive these port cores are seen at e' f' in Fig. 14. Like the pattern, these boxes are made so that the length can be changed. Fig. 14 shows a piece, l, fastened in the center of one side of core-box, and on the opposite side there are two pieces, m, n, which, together, are equal in length to l. When it is necessary to extend or shorten the box, the pieces o p in Fig. 14, that hold the box together, are taken off. Notice that piece o runs between two other pieces, that form the inlet. I would suggest that o p be doweled on, as well as screwed, so that, when changing the length, they can be easily located, without depending on the screw holes. The outside pieces m' n' do not run the whole depth of box; they are two cleats, screwed on the sides of valve chamber ends, to prevent them from splitting.

The exhaust core-box, of which Figs. 18, 19, 20, and 21 are four views, is made open on one side between the valve chambers, and, as this open side is a plain, straight surface, it can be swept off with a "moulder's straight-edge"; the moulder should round off the corners of core along the edges, to match those in core-box. The valve chambers are round, all the way through in this core, as will be seen on referring to Fig. 15. Like the core-box for the steam side, two pieces, r, s, Figs. 18, 19, are inserted, for changing the length. Fig. 18 shows a section of the box; the two sides are carried above the center line of valve chambers. Fig. 16 shows that the side of core runs over the center line G, H, hence the necessity of carrying the sides of box above the center of valve chambers.

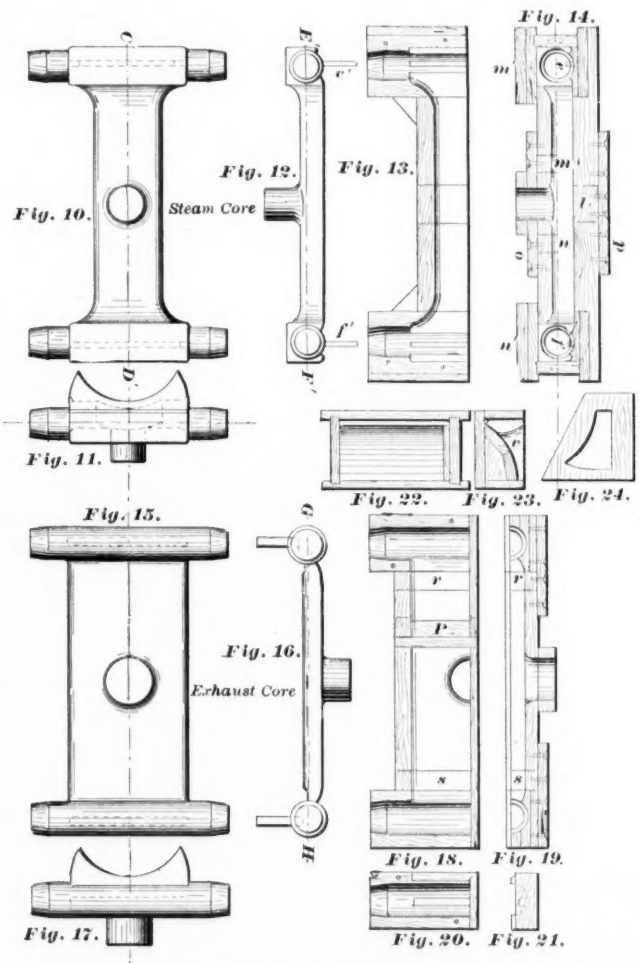
Figs. 20, 21, are two views of the port halves of valve chambers, and, like the steam core, the port cores are made separate and pasted in. In small size Corliss cylinders whole core-boxes are sometimes made, instead of half core-boxes; in many respects this is to be preferred.

One core-box will do for the exhaust and steam ports; make it like Fig. 24, same thickness as the exhaust port, and for the steam port core, make a loose piece and drop in the bottom of box.

The box for coring out the space that separates the body of cylinder from the exhaust passage may be made as shown in Figs. 22 and 23. Make the box half the length of the space. (See Figs. 1 and 2 at T.) It will be seen that, in the center of this space, there is a bridge; to form this a loose piece, V, Fig. 23, half the thickness of bridge, is made, and fitted in the end of core-box, and, as there must be one right-hand and one left-hand core, changing this loose piece to the opposite end will give it. It will be found that two other small cores are wanted, one right-hand and one left, to core out between the valve chambers and cylinder on the exhaust side. These small cores are really a part of the core for coring out the space T, Figs. 1 and 2, and might be made in one core, like the core print shown in Fig. 6, but I think it is easier to make them separately. I have not shown these small boxes, as they will be readily understood without.

Doubtless there are many who will object to casting these cylinders on their side, thinking they can only be made free from dirt when cast on end. To those who have that impression, I would like them to call at the M. C. Bullock Manufacturing Co., Chicago, and I would show them cylinders cast on their sides, that cannot be beaten for being free from dirt and all the evils that afflict cylinder castings.

Those who make Corliss cylinders will, no doubt, see the advantage of making their patterns the way I have shown, and yet there may be some "pointers" omitted, that many of the readers of the AMERICAN MACHINIST might give, and be none the poorer.



CORLISS ENGINE CYLINDER PATTERNS.

The newspapers are often most humorous when they least intend to be. One of them recently gave an account of the explosion of a vulcanizer in a dentist's office, and stated that, "Though the vulcanizer was not more than six inches in diameter, and eighteen inches in height, it contained 365 pounds of steam." The trodden worm will turn, and we can hardly blame such a small boiler for kicking up a rumpus when imposed upon in that manner. Of course, that newspaper chap meant 365 pounds pressure per inch; but we wonder how much larger he thought the boiler should be to stand that pressure safely.

Another queer dream that seems to have proven a real, substantial warning, is told by a fireman on the Baltimore & Ohio road. Frank Baker tried to get out of his run when his freight was ready to leave Wheeling, by feigning sickness. Not being able to get off, he bade his wife good-by, telling her he had dreamed of a fatal accident, and that all would be killed. When the freight took a siding at Valley Falls, Baker made an excuse and left his engine. A moment later an express crashed into the freight, and the engineer and brakeman in his place were killed.—*Kansas City Times.*

According to a correspondent of the *Electrical World*, J. W. Granger, instructor in the Sibley College blacksmith shop, has succeeded in welding copper at the forge, having made a chain of $\frac{5}{16}$-inch copper wire.

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Suburban Traffic.

It is conceded, we believe, by nearly all who have had an opportunity to compare the railroad systems of this country with those of England, that the American roads possess many points of superiority. But, on the other hand, it must be conceded that, in the matter of suburban traffic, the English roads are ahead; giving to the people a better service at a much lower cost. As cities increase in size, and land values increase, it becomes more and more difficult, if, indeed, not less desirable, for most people to make the city a place of residence. There are in round numbers 1,080,000 people who are living (?) in tenement houses in New York city, and the balance, most of whom live in what are little better, though more euphemistically called "apartment houses," are greatly overcrowded and deprived of privileges which every human being should have, and can usually secure in the country or in smaller towns.

There is no doubt whatever that a much larger proportion of the people who must work or go to business in New York every day, would live out of the city, under the better sanitary and moral surroundings to be secured thereby, if the facilities for getting back and forth between their suburban homes and the city were improved. No one, who has observed the management of suburban traffic, about New York, Philadelphia, Chicago, and others of our large cities, can doubt that there is much room for improvement, and that the railroads, by a more general recognition of the peculiar requirements of a satisfactory suburban train service, might easily bring about such a distribution of population within a radius of thirty miles about our great cities, as to build up for themselves a very profitable business, and one which could be depended upon as long as the roads continue to exist.

But it must be clearly recognized that good train service, and accommodation generally, must precede a growth of population in a suburban location. No suburban town can attract people from the city, unless, first of all, its train service is as good as that of other similar places. And of places which otherwise offer equal advantages, the one which possesses the best accommodations for getting to and from the city will receive the overflow of people, and the road leading to it will do the business.

But too often it seems to be the policy of the roads to furnish just sufficient accommodations to prevent their patrons from moving bodily into the city, and to give the larger towns far the better train service, seeming to overlook the fact that their patrons live in the country expressly to escape the features of large towns, and that, by giving equally good train service to all desirable suburban towns, they would all rapidly build up to the limit of population which would leave them desirable as places of residence. The arrangement of trains and time tables should be as much with reference to prospective growth of business, as to the accommodation of people already living on the lines.

Then in the mechanical department it should be recognized that the problems presented by suburban traffic differ from those of through traffic, and require different treatment. A locomotive entirely satisfactory for a through express is not adapted to service on suburban trains. This is well recognized in England, and the engines used on suburban trains there are especially designed for that service, have proportionately smaller drivers, great weight upon them, and great cylinder power, with small tanks—only just sufficient in size to carry enough coal and water for the short runs. Then the cars, while they need not be splendidly finished, should be well heated, their temperature being regulated by a thermometer, instead of by the whim of the trainmen or passengers. They should be well lighted both naturally and artificially, so that newspapers and books may be read in them comfortably and without injury to the eyes. To this end, also, the wheels upon which they run should be round and true, and defective ones promptly replaced. When men ride in cars sufficiently well lighted, and with the wheels and track in sufficiently good condition to admit of reading the morning and evening papers on the way to and from the city, they are not apt to consider the time spent upon the road as lost. But if they must play cards or look out of the windows at scenes which they have looked upon thousands of times, they begin to wonder if it is not worth while to live in the city, and save the time spent in getting back and forth.

To sum up, trains should be frequent to and from all desirable places of residence, regardless of present population. They should be fast—drawn by engines capable of making them so. The cars should be especially adapted to the service—well lighted, comfortable, and easy riding, even at the sacrifice of mere ornamentation or gorgeousness. And finally, the service should be as cheap as is consistent with fair returns to the roads.

Electric Sugar Refining—One of its Lessons.

Our acquaintance with that mysterious and impalpable agent, which we call electricity, is becoming better day by day. Scarcely can one pick up a newspaper, these days, without seeing an account of some new and wonderful thing which is to be accomplished by its agency. But, amongst all the other wonderful things which have been accomplished by electricity, none is more wonderful than its recently proven power to deprive men of their ordinary wits, and render them willing, nay, even anxious, to put their solid cash into the hands of an adventurer, who merely mentions electricity, without going so far as to actually employ it.

A man calling himself a "professor," allows his dupes to see him take raw sugar into a mysterious room, the contents of which none of them have been permitted to see. After a time he passes out some refined sugar, and the dupes accept his word for it that it is the same sugar which they saw going in unrefined, and that it has been refined by an electric process, costing at the rate of a few cents per ton, or a saving of $12 over the ordinary methods. These "shrewd and hard-headed business men" see nothing of the process nor of the means by which it is accomplished, have no means of knowing that the refined sugar shown them is the same which they saw going in as raw sugar, see none of the refuse; in fact, are entirely without the evidence usually required by men who are in possession of their senses, as to the value of an investment before going into it; yet, remembering that "we live in a wonderful age," that things are constantly being done, which, a short time ago, would have been pronounced impossible, and, above all, remembering that *electricity* has something to do with this, they climb over one another in their eagerness to invest, and to "get in on the ground floor."

A few years since it would have been deemed impossible for the human voice to be transmitted through long distances over a wire, yet electricity has done this, and what is there, they ask, more mysterious or unreasonable about this sugar refining scheme than in the telephone?

It is not the worst feature of this case that certain men have lost a good deal of money by this fraud, but that others, who have really practical, honest and valuable discoveries and inventions, will be prevented from making them useful to the public, on account of the distrust caused by this sugar incident. It is to be hoped that the day will soon come when business men and capitalists will realize that one who is without scientific training and experience is utterly unfit to analyze such matters, and to distinguish between the probable or possible, and the improbable or impossible. When that day arrives, capitalists proposing to go into new schemes will employ competent engineers, to examine and report upon them. In this way only can the interests of honest men be properly guarded. And it may be set down as a safe rule that a man who solicits subscriptions to stock, in a process or device which he refuses to allow the full examination of by honest and skilled engineers, in the interest of those from whom he solicits subscriptions, is a fraud.

The Transatlantic Trip of the Mechanical Engineers.

Arrangements are practically completed for the summer meeting of the American Society of Mechanical Engineers in England. Already one hundred and seventy have pledged themselves for the trip, and many more expect to go. The associations of mechanical and civil engineers, and other associations in England, have extended a welcome and many courtesies in advance, amongst which is the tender of transportation to and from England to the Paris Exposition. The trip will, if the weather is fine, be a pleasant one, and it will undoubtedly be a profitable one to those who go. There are many things in England that American engineers would be better for seeing, to say nothing of what may be seen at the Exposition. Such a trip cannot fail to broaden the ideas of those taking it, especially so since the courtesy of English engineers will be sure to bring to their notice things that would not otherwise be seen. We congratulate every member of the American society who is so circumstanced as to take the transatlantic trip.

Those who congratulate themselves that the recent decision of Judge Barrett against the North River Sugar Refining Company is to settle the question of the sugar trust, are likely to be disappointed. They will go right on paying one and one-half to two cents a pound more for their sugar, all on account of the trust, just as they did before Judge Barrett's decision. The decision—and it is a righteous one—is to the effect that the North River Co. has forfeited its charter through joining the trust. This is in accordance with the common sense idea that a charter is not granted to a company simply for the sake of putting that company in the way of making money; the company is supposed in some way to benefit the public as a condition of its existence. But if Judge Barrett's decision stands the scrutiny of the higher courts—which it is very likely to do—it will not seriously affect the sugar trust. It may modify somewhat their method of doing business, but it is reasonably safe to say that the trust will exist just the same, and that the stockholders of the North River Company will be interested parties to its existence.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and aduress. If so requested, neither name, correct initials nor location will be published.

(35) J. J., Newark, N. J., writes: We have a large safe on which the paint has cracked and come off. We wish to paint it ourselves, for certain reasons. A safe maker in New York told us to take all the paint off and paint with carriage varnish and solid pumice stone. What we want to know is this: 1. Can carriage varnish be got any color, and is it the proper thing to use? 2. How is the pumice to be used, and when, before or after painting, and what is it used for? *A.*—Carriage varnish cannot be obtained in any color. We believe the best way to proceed is to scrape off the old paint, then re-paint with paint of the desired shade. If it is a dark color, varnish it with good coach varnish; if it is a light color, use white Demar varnish. If a very smooth job is required, rub down the varnish, when it is perfectly dry, with pumice stone dust and oil.

(36) J. W., Wahoo, Neb., asks: 1. What depth of water should be carried above the top row of tubes in a common tubular boiler for the best results, economically? *A.*—It is very common practice to carry 4 to 8 inches of water above the tubes. An engineer will determine by trial under what conditions as to water level his boiler steams best; then, if it is between the danger limits of burning his boiler on one hand, and priming on the other, he will carry his water where he fires the easiest. 2. Does a large boiler require more water above the tubes than a smaller one? *A.*—No, not necessarily, but it is generally, though not always, practicable to carry the water higher above the tubes in a large than in a small boiler. 3. Is it a good plan to feed a boiler from the top, letting the feed pipe run down to within an inch of the tubes, and then discharge on a plate of sheet-iron turned up two inches all around the edge? *A.*—Yes.

(37) J. D., Newport, R. I., writes: Please give me the rule for finding the quantities of coal contained in bunkers of such forms as shown in Figs. 1, 2 and 3. Also the quantities of water contained in tanks of similar shape. *A.*—In all such problems, first find the number of cubic feet contained in these bunkers or tanks. For finding the cubical contents of Fig. 1 we have the following rule: Add the lengths of the edges *a b* and *c d*; divide this sum by 2; the quotient will be the length of the line *h i* drawn midway between, and parallel to the lines *a b*, *c d*. Multiply the length of the line *h i* by the edge *a c*. This product will be the area of the side *a b c d*. Multiply this area by the width *a e* or *b f*; the product will be the cubical

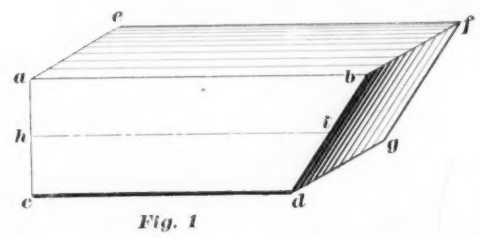


Fig. 1

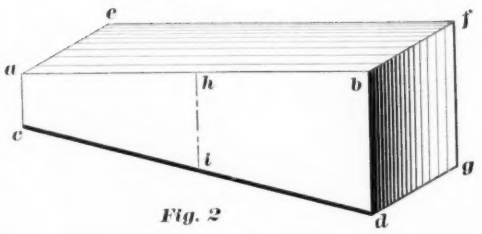


Fig. 2

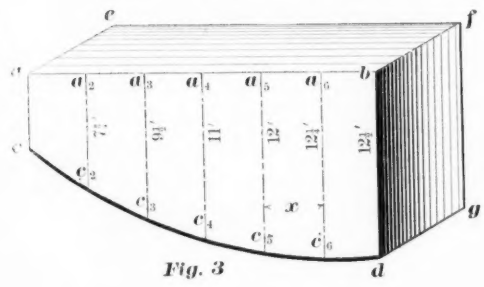


Fig. 3

contents of the tank or bunker shown in Fig. 1. Example 1: Let *a b* be ten feet, *c d* 8 feet; *a c* 5 feet, and the width *a e* or *b f* equal to 6 feet; it is required to find the cubical contents of this tank or bunker.

$$\frac{10+8}{2} = 9 \text{ feet, which is the length of } h\ i.$$

Again, $9 \times 5 = 45$ square feet, which is the area of the side *a b c d*. And

$$45 \times 6 = 270 \text{ cubic feet,}$$

which is the cubical contents of the tank or bunker shown in Fig. 1. To find the contents of Fig. 2 we use a similar rule, namely: Add the edges *a c* and *b d*, divide their sum by 2, which will give the length of *h i* drawn midway between and parallel to these edges. Multiply *h i* by *a b*; the product will be the area of the side *a b c d*. Multiply this area by the width *a e* or *b f*; the product will be the cubical contents of the figure. Example 2: Let *a c* be 3 feet; *b d*, 6 feet; *a b*, 9 feet and *a e* or *b f* equal to 4 feet; it is required to find the contents of this figure.

$$\frac{3+6}{2} = 4\tfrac{1}{2} \text{ feet, which is the length of } h\ i.$$

$$4\tfrac{1}{2} \times 9 = 40\tfrac{1}{2} \text{ square feet,}$$

which is the area of the side *a b c d*. And $40\frac{1}{2} \times 4 = 162$ cubic feet, which is the cubical contents of Fig. 2.

For finding the cubical contents of Fig. 3 we must first find, as in the other figures, the area of the side *a b c d*. For finding this area we have the following rule: Divide the edge *a b* into any number of equal parts; through the points of division a_2, a_3, a_4, a_5, a_6, draw lines perpendicular to *a b* and terminating in the curve *c a*. Find the length of the lines $a_2\ c_2$, $a_3\ c_3$, etc., by measurement. Add the lengths of the lines $a_2\ c_2$, $a_3\ c_3$, $a_4\ c_4$, $a_5\ c_5$, $a_6\ c_6$, and to this sum add one-half of the sum of the edges *a c* and *b d*. Multiply this total sum by the distance *x*, that is, the distance between any two consecutive lines drawn perpendicular to *a b*; the product will be the area of the side *a b c d*. Multiply this area by the width *a e* or *b f* of the tank; the product will be the cubical contents of Fig. 3. Example 3: Let the edge *a c* be 5 feet; the edge *b d* $12\frac{1}{2}$ feet; the length *a b* 30 feet; and the width *a e* 6 feet. It is required to find the cubical contents of the tank (Fig. 3). First divide the edge *a b* into any number of equal parts, say 6, and through the points of division draw the lines $a_2\ c_2$, $a_1\ c$, etc., perpendicular to *a b*. Suppose that by measurement we find the lengths of the lines to be as marked in the figure; then we have,

$$7\tfrac{3}{4} + 9\tfrac{1}{2} + 11 + 12 + 12\tfrac{1}{4} = 52\tfrac{1}{2}.$$

Again, one-half of the sum of the two edges *a c*, *b d* is

$$\frac{5+12\frac{1}{2}}{2} = 8\tfrac{3}{4}. \text{ And } 52\tfrac{1}{2} + 8\tfrac{3}{4} = 61\tfrac{1}{4}.$$

The distance between any two consecutive lines drawn perpendicular to the edge *a b* is 5 feet; hence we have

$$61\tfrac{1}{4} \times 5 = 306\tfrac{1}{4} \text{ square feet,}$$

which is the area of the side *a b c d*. Lastly, multiplying this area by the width *a e* of the tank, we have $306\frac{1}{4} \times 6 = 1,837\frac{1}{2}$ cubic feet in the tank of the form as shown in Fig. 3. After we know the number of cubic feet in each figure, we can readily find the quantity of coal or water which each bunker or tank will hold. A cubic foot will hold about 50 pounds of broken coal; hence we have only to multiply the number of cubic feet in a bunker by 50; the product will be the weight in pounds of coal which the bunker will contain. Thus, for instance, in our last example we found that a bunker, of the form as shown in Fig. 3, contains $1,837\frac{1}{2}$ cubic feet; hence, this same bunker will contain

$$1,837\tfrac{1}{2} \times 50 = 91,875 \text{ pounds,}$$

$$\text{or } \frac{91,875}{2,000} = 45.93+ \text{ tons of coal.}$$

A cubic foot will contain 7.48 U. S. gallons; hence, if Fig. 3 represents a tank, this tank will hold $1,837\frac{1}{2} \times 7.48 = 13,744.5$ gallons of water.

From the pounds of coal, or the number of gallons found by these calculations, deduct about two per cent. for braces, angle iron, etc.

(38) Steam, Providence, R. I., asks: Will you kindly give me the titles of two or three good works on Kinematics, and also on Steam Boilers? The works on boilers bearing more on the theoretical and comparative efficiency of boilers than on the practical details of boiler making. *A.*—There are a number of good works on Kinematics; it seems to us that you cannot fail to make a satisfactory choice. We cannot give the names of all of them, and to give the names of a few works would be doing an injustice to others. The same remarks apply to works on steam boilers; but we will say this, that we generally refer to the Manual of Steam Boilers, by R. H. Thurston; Steam Boilers, by W. H. Shock; Practical Treatise on High Pressure Steam Boilers, by W. M. Barr; Experimental Researches in Steam Engineering, by B. F. Isherwood, and a number of others.

(39) J. B. C., Auburn, N. Y., asks: What is the pay in New York City of a first-class pattern maker? *A.*—The pay varies from about $3.50 to $5.00 per day. 2. What is the pay in the navy yard, and how many are employed, and is there much work at present at pattern making? *A.*—The pay at the navy yard is about the same as that paid by private establishments. The number of men employed in the navy yards depends upon the appropriations made by Congress. For other information regarding work at the navy yard, write to the master mechanic.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc., J. B. Roney, Lynn, Mass.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Power measured with guaranteed Dynamometers. Franklin Van Winkle, 91 Liberty st., New York.

Drop presses, punches and shears. Williams, White & Co., Moline, Ill., manufacturers.

"How to Keep Boilers Clean." A 96 page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N. Y.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Common-sense oil filters are a wonder. They repay cost quickly. C. F. Baker, Minneapolis, Minn.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Upright drills, improved, sizes 21", 23", 25", 28", 32", 36" swing; finely made and great capacity. Currier & Snyder, Worcester, Mass.

Patents obtained. Patent litigation conducted. R. G. DuBois, Patent Attorney, 928-930 "F" street, Washington, D. C. Correspondence invited.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

See illustration of improvements in Hooks for Steam Engines, in Nov. 24 issue. For particulars address T. C. Dill Machine Co., 726 Girard av., Phila., Pa.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y. City.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Jan. 3, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

With my System, Exhaust Steam Heating costs nothing for fuel; Live Steam Apparatus altered to Exhaust. Satisfaction guaranteed. Geo. A. Barnard, 15 Cortlandt street, New York.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing grey iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N. Y.

The Vance Lightning Flue Cutter is *the* tool for removing old flues from boilers and locomotives (will cut fifty an hour); sent on approval to railroad companies. Vance Tube Cutter Co., Geneva, N. Y.

A system of easy lettering, by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Catalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.

Special facilities for the manufacturing of all kinds of light machinery, hardware and novelties, by contract or otherwise. Presswork and stamping done on short notice. Estimates furnished. Punches, dies and special tools made when required. Rockaway Mfg. Co., 3 E. 14th street, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including Jan. 3, 1889 issue, 67 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 82 articles have thus far appeared up to and including the Jan. 10, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURERS

D. E. Burgh will build a machine shop at Roanoke, Va.

E. C. Hanson contemplates starting a watch factory at Atlanta, Ga.

The Central Railroad Co. will increase the capacity of their shops at Macon, Ga.

The Grafton Flax Mills Co., North Grafton, Mass., contemplate building a new mill.

The Marion (Ark.) Land & Improvement Co. propose to start a furniture factory.

Geo. E. Knowles & Co., of Philadelphia, are building a knitting mill at Sheffield, Ala.

There is a proposition to turn the old agricultural works at Peru, Ind., into a car manufactory.

H. K. Porter & Co. (Pittsburgh) are about completing six small locomotives to go to Buenos Ayres.

The Alabama Great Southern Railroad Co. will build an addition to their machine shop, at Birmingham, Ala.

The Newport News & Mississippi Valley Railroad Co. will build shops at Lexington, Ky., if $35,000 is donated.

The Crozer Steel and Iron Co., of Roanoke, N. C., will build an additional iron furnace at a cost of about $125,000.

The Frisbie & Stansfield Manufacturing Co., of Camden, N. Y., has been incorporated, to manufacture knit goods. The capital stock is to be $66,000.

George Goodwin & Co., of West Poland, Me., propose to erect a steam mill in which they will manufacture a variety of lumber, at Mechanic Falls, Me.

The stockholders of the Appleton Cotton Mills, of Lowell, Mass., voted recently to sell about $100,000 worth of real estate, and apply the proceeds to the purchase of new machinery.

There is water-works agitation at Saltsburg, Pa.; Butte City, Mont.; Abington, Pa.; Roanoke, Va.; Myerstown, Pa.; Atlanta, Ga.; Rogers Park, Ill.; Helena, Ark.; Jenkinton, Pa.

The Lloyd Foundry and Machine Works, of Kansas City, are increasing their capacity by putting in a new steam forge and 1,200 pound steam hammer, and also nut and bolt machinery in a new addition adjoining their present shops.

The shoe factory at Bucksport, Me., has been closed for some time, and the business men of the place are trying to find some enterprising parties to start it up. The factory will be given rent free, the taxes remitted by the town, and other advantages.

The Kentucky Bobbin Company, with an authorized capital of about $50,000 has been organized in Louisville, to manufacture bobbins and spools for woolen and cotton mills. The factory will be the only one of that nature south of the Alleghany mountains. All the wood used in the making of bobbins and spools is to be obtained in Kentucky. The works will be in operation about March 1.

The Pole Road Locomotive Company has been chartered, to manufacture pole road locomotives at Richmond, Va., with R. A. Lancaster, of New York, as president; William H. Lucke, secretary and treasurer, and J. A. Yancey, general manager. The capital stock is not to be less than $150,000 nor more than $500,000.

The Elizabethport (N. J.) Cordage Works is about to be extended to First street, and much enlarged. The works, when enlarged, will be the biggest of the kind in the world, and will employ 1,200 operatives. A large factory, for the manufacture of bags in which to wrap up the twine and rope made by the firm, will be a new feature. The works now employ 600 hands.

A new artificial ice company has been formed in Union County, N. J., with a capital of $100,000. Sheriff Glasby, of Union, is the president of the company, and the plant will be situated at Elizabeth. Eight thousand dollars has been paid for a tract of land 470x200 feet on East Grand street, on which large buildings will be erected, the work to begin immediately.

The Pratt & Whitney Co. (Machinists' Tools, Forging and Finishing Machinery for Sewing Machine and Gun Manufacture, and Special Purposes), Hartford, Conn., write us: The number of men employed and the amount of business done by the Company in 1888 were about 15 per cent. less than in 1887. The storehouse, finished early in the year, has been fitted up with an elevator, overhead tramways, trolleys, and a portion of two floors utilized for a pattern shop and the heavy work upon the Hotchkiss rapid firing gun. Two Beach water leg boilers of 60 horse-power each, and a Straight Line engine have been added to the plant. The business outlook for 1889 is very encouraging.

J. Wyke & Co. (Machinists' Tools, Fine Graduating a Specialty), East Boston, Mass., write us: Our business of the past year has been as we predicted at the beginning of the year. Our business has increased considerably, and we are now behind orders. We have put in new engine and boiler, one 16-inch engine lathe, and several other tools that are required on our work. We find that some of our improved tools, which we have had on the market about six years, are now being imitated by at least one of the most celebrated tool manufacturers of the country. This has constrained us to reduce prices a little, but, although this (imitating business) speaks well for our tools, if not for those who do the imitating, we have every confidence in the coming year, 1889, and believe that our business will go on increasing.

The Westcott Chuck Company (Westcott's Lathe and Drill Chucks), Oneida, N. Y. write us: The business year just closed—1888—has proved beyond our most sanguine anticipations. The growing demand for our deservedly popular chucks in all their variety has taxed to the utmost our capacity to fill orders, the works being in full operation at night for two-thirds of the year. 1889 finds the manufacturing capacity doubled, and this, with the aid of improved machinery and skilled labor, will enable us, we hope, to satisfy the heaviest demands promptly. Orders from our own and foreign countries are rapidly increasing, and the field widening. It is our intention to make good our claim to the production of the best lathe and drill chucks ever put on the market. The outlook for present year is extremely encouraging. No changes to be noted in the labor market. Wages steady.

From present indications it would seem that the Standard Oil Company will utilize a portion of Breaker Island [Troy, N. Y.], for the erection of a pipe foundry in connection with the blast furnaces now in operation on the island. To-morrow the blast furnace now being used will commence to turn out mill or foundry iron instead of Bessemer steel pig, as heretofore, and this fact is regarded as significant, that it is an experiment for the purpose of ascertaining the utility of the furnaces in that direction. Nothing but Bessemer pig iron has heretofore been turned out. The company has 30,000 tons of the latter material on hand, and it is stated by Vice-president Kemp that steel rail orders are very slow in coming in at present. Both furnaces, Nos. two and three, are being re-lined at present and only number one is working. The establishment of a pipe foundry near the furnaces would be very beneficial to this section of the country.—*Northern Budget.*

The Heisler Electric Light Co. [St. Louis, Mo.] have been awarded the contract for lighting the American department of the Paris Exhibition. The whole plant required for this purpose will be completed and tested before shipping, at the St. Louis Illuminating Company's station, where our local technical societies will be invited to witness its achievements. It will consist of a dynamo of 1,000 incandescent light capacity, showing the utility of a 2 independent circuit system, each room or locality wired from both circuits. Lamps will be exhibited from 10 up to 300 candle power; the automatic regulation will be so arranged as to indicate the reduction of power when lights are turned off; 10 miles of circuit wire No. 8 will be inserted, so as to indicate the practicability of carrying the current to any desired distance; registering current meter will be included in the exhibit; twenty-four clusters of incandescents will be suspended from the ceiling, of various candle-power, posts being provided with side brackets, such as used for indoor; but in addition, 50 street lamp brackets will be fastened to posts, to indicate a system of street lighting as used in a great number of our American cities.—*Age of Steel.*

Machinists' Supplies and Iron.

NEW YORK, Jan. 19, 1889.

Iron—American Pig.—The competition of Southern brands has been quite distinctly felt, and as consumers seem reluctant to contract for more crude iron than is actually needed for immediate use, the condition of the market has been unsatisfactory, and there are some indications of new quotations to meet the Southern competition. We quote Standard Lehigh and North River brands, No. 1 X Foundry, $18; No. 2, $17; Grey Forge, $16.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—See bottom of third column, page 11.

Thorough mechanic desires employment; experimental or tools. Address L. X., AMERICAN MACHINIST.

Wanted—By practical pattern maker and draftsman, position as foreman pattern maker. S. K., AMERICAN MACHINIST.

Wanted by practical boiler maker, position as foreman; over 20 years' experience; have references. B. M., AMERICAN MACHINIST.

To Blacksmiths. Wanted—A locomotive frame maker to work by piece; steady employment. Correspondence invited. Blacksmith, AM. MACHINIST.

Wanted—First-class hand on No. 11 Jones & Lamson screw and stud machine; state experience, age and wages expected. BOX 60, AMERICAN MACHINIST.

Wanted—A good mechanic and business manager, to take $5,000 to $10,000 interest in a good Iron Works in California, doing well; all young and practical men connected. A. B. C., Oakland, Cal.

Situation wanted by blacksmith, 30; been foreman in this country and Scotland; experience in light and heavy engine work, and can get work out fast with steam and drop hammers. J. H. G., AM. MACHINIST.

Wanted—A few good bench hands to work on wood-working machinery; must have experience in the line, and none but first-class vise hands need apply. Address The Indiana Machine Works, Fort Wayne, Ind.

A first-class draftsman and mechanical engineer wants position with some responsibility and prospects for advancement; graduate of polytechnicum abroad; 8 years' exp. in water-power and pumping mach., locomotives, steam eng. compound and triple exp.; energetic and accurate; best references. Address R., 30, AMERICAN MACHINIST.

Wanted, Foreman—A young man well up in modern machine shop practice and used to handle men can find position as foreman in small department of established business where there is chance for advancement; ambitious party familiar with interchangeable work will find this a desirable opening. State previous experience, age, and wages expected. Box 61, AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent steel tube scrapers are unquestionably the best. Crescent Mfg. Co., Cleveland, O.

Crescent boiler tube cutter, for setting new and removing old tubes. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

August C. Christensen, 24 State st., N. Y., consulting engineer for hydr. and pumping machinery, etc.

Punches, Dies and special machinery built to order. C. F. Langston & Co., 70 N. 4th St., Phila., Pa.

Correspondence solicited with parties having machine or foundry specialties to build. Honesdale Iron Works, Honesdale, Pa.

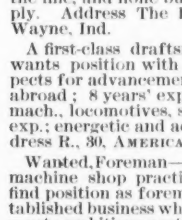
Wanted—Single stand steam hammer, new or second-hand, 400 to 600 pounds. Give maker's name and price. P. O. Box 324, Chicago, Ill.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Wanted.—To buy second-hand lathes, planers and shapers of all sizes; must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets' Cincinnati, O.

Experienced steam engineer desires correspondence with parties wishing to increase their business or to engage in the manufacture of something new. Address "Reliable," AMERICAN MACHINIST.

Business Opportunity—To a live business man with small capital; to the right party an interest in and charge of the financial and sales department of a well-established plant for mfg. high class steam engines, saw mills, or electrical machinery; location and shipping facilities unsurpassed in Eastern Ohio. Address F., care AMERICAN MACHINIST.



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For cutting the teeth of gears; one Cutter cuts a pitch from 18 teeth to a rack inclusive.

Send for descriptive circular and price list.

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For Circulars address THE TANITE COMPANY, STROUDSBURG, MONROE CO., PA.

Or H. A. ROGERS, 19 John St., N. Y.

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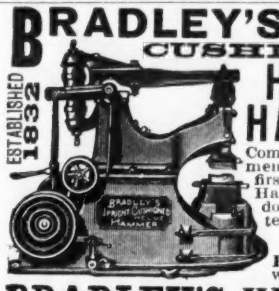
ESTABLISHED 1832



Combines the best elements essential in a first-class Hammer. Has more good points, does more and better work and costs less for repairs than any other Hammer in the world.

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Pat. Aug. 30, 1887.

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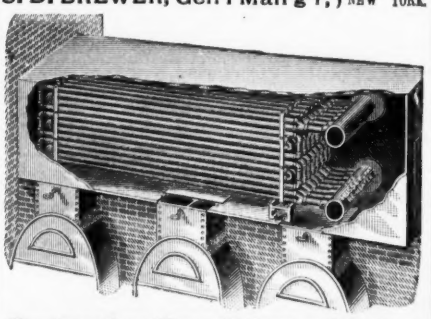

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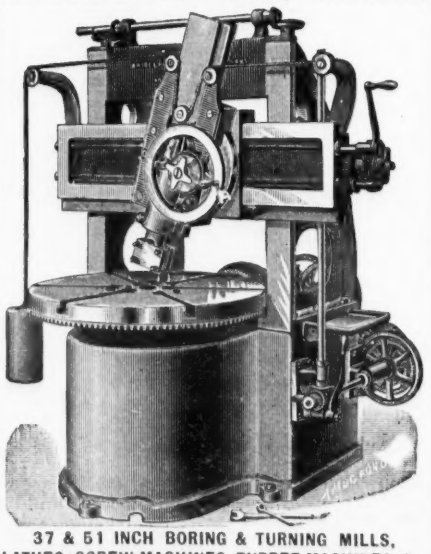

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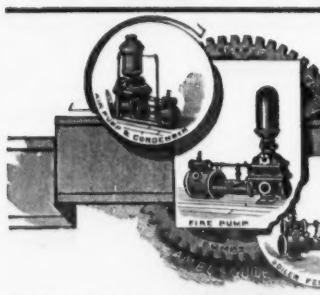

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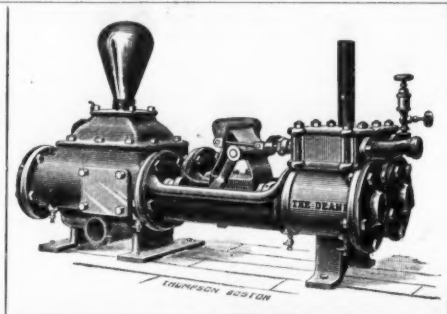

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STEAM and POWER PUMPS

FOR ALL PURPOSES.

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Stationary or Patent Swivel Bases.

INCOMPARABLE FOR STRENGTH, DURABILITY FIRM HOLD AND QUICK WORK.

Has improved Taper, Pipe and other attachments. Made in 2, 2¾, 3½, 4½, 5½, and 6½ inch width of jaw.

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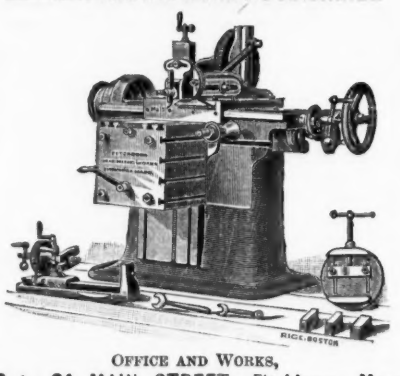

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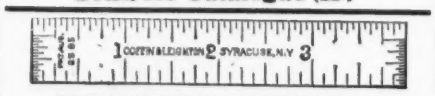

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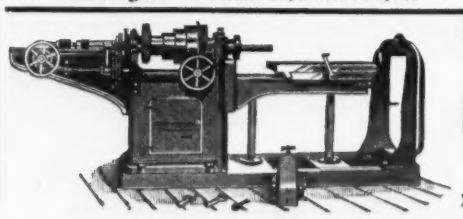

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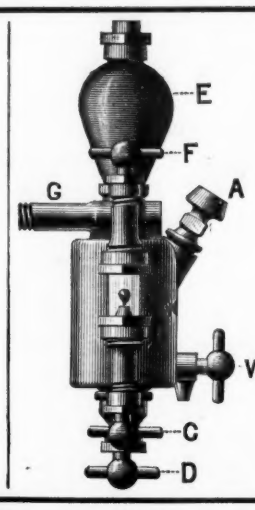

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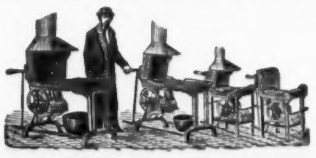

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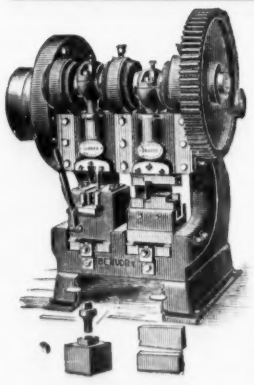

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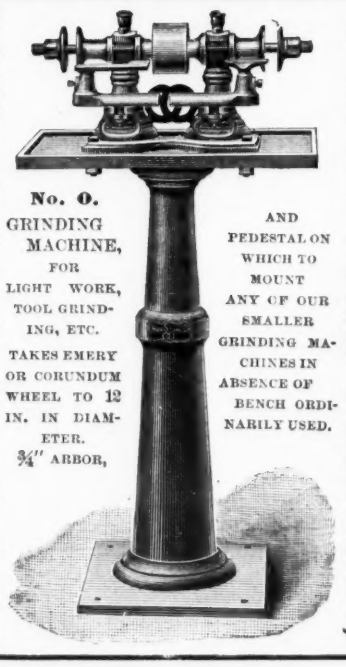

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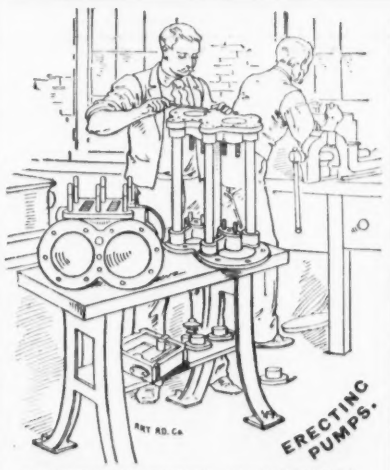

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3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set		31.10

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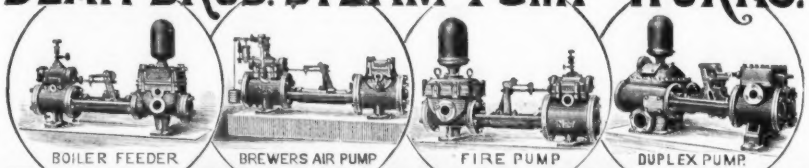

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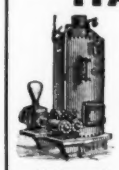

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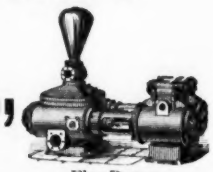
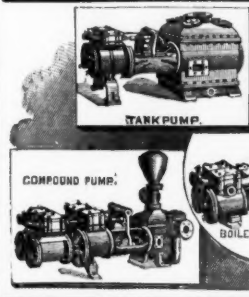


Fire Pump.



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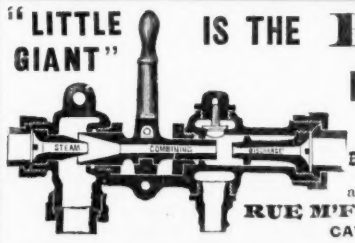

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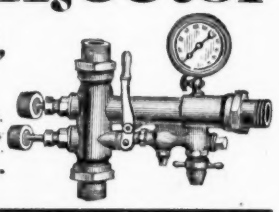

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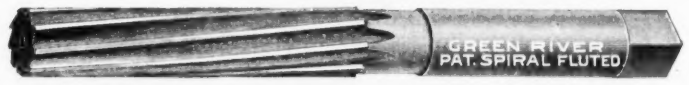

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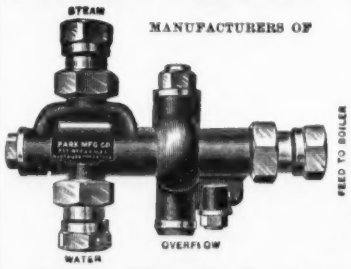

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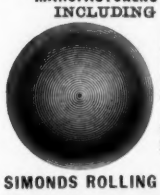

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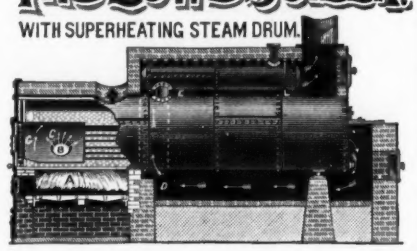

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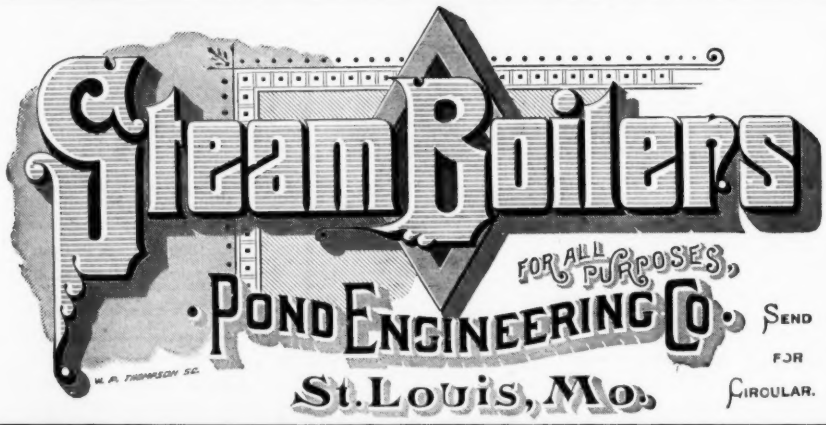

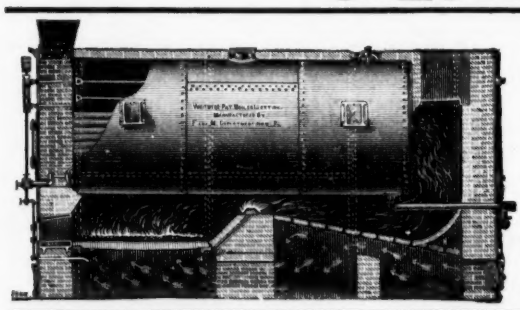

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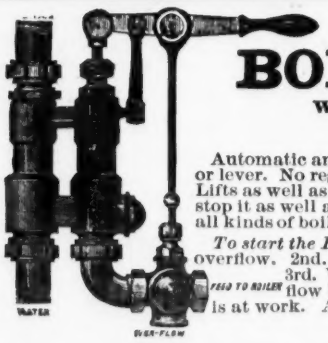

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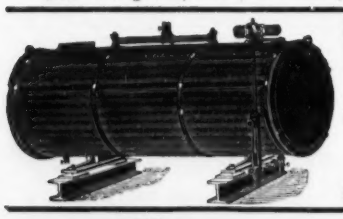

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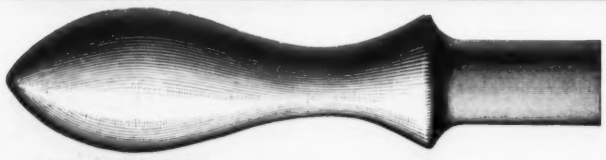

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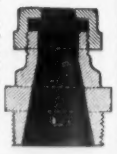

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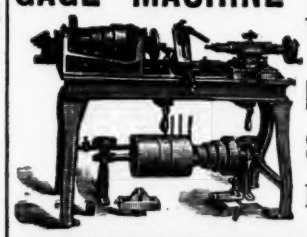

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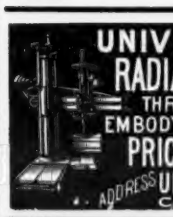

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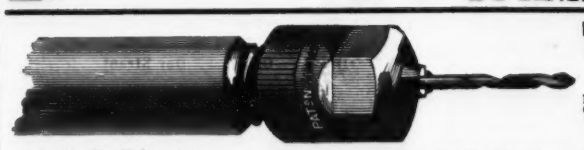

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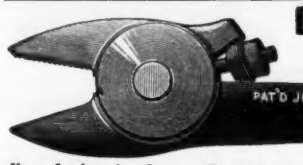

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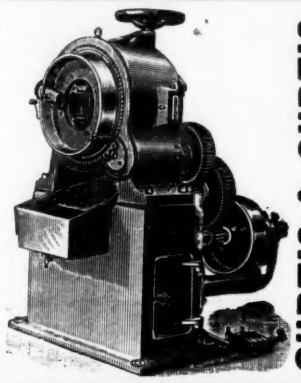

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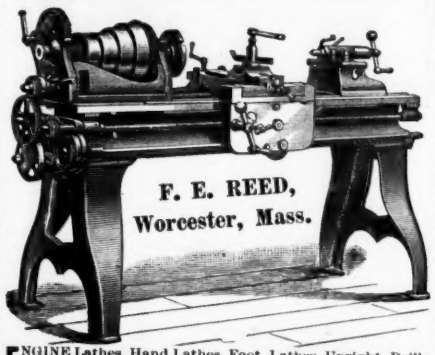

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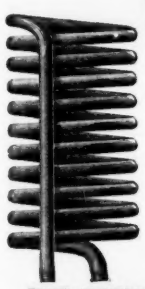

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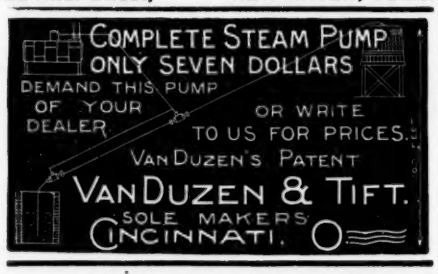

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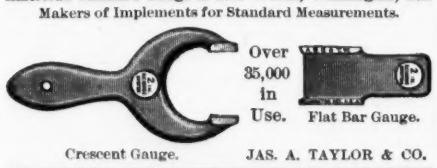

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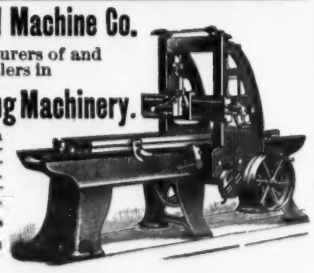

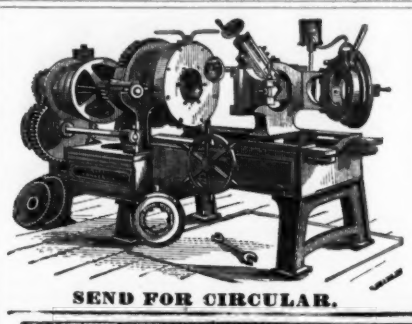

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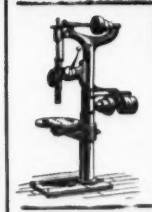

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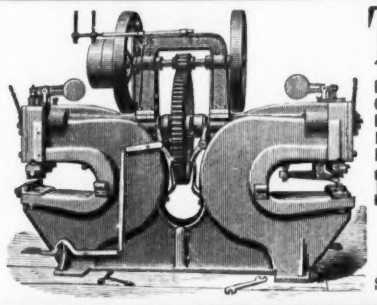

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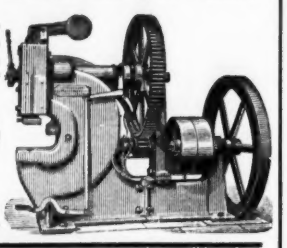

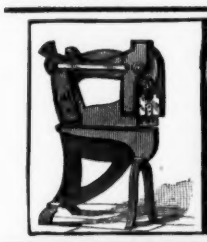

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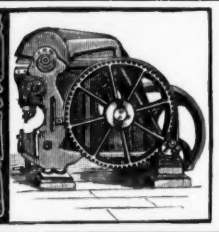

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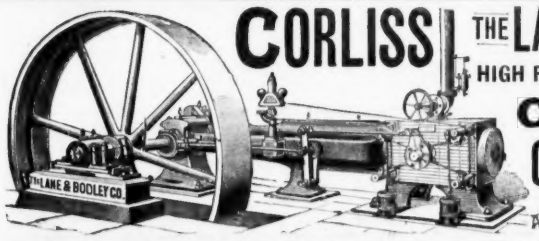

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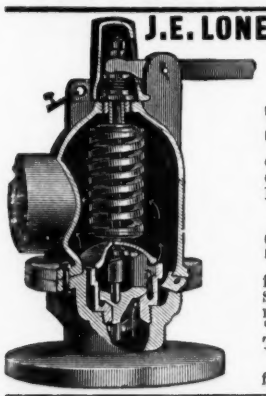

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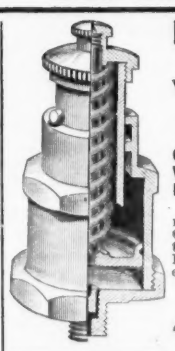

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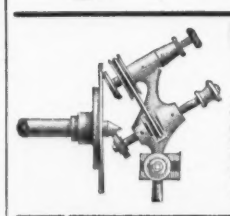

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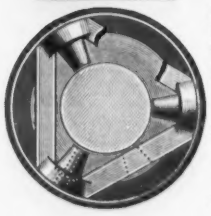

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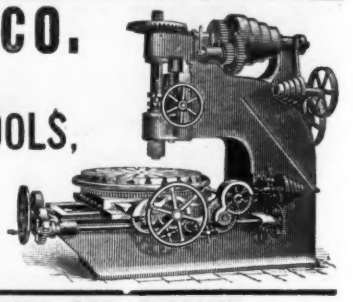

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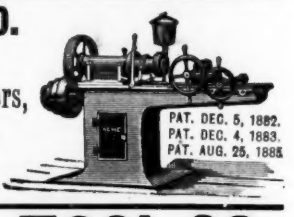

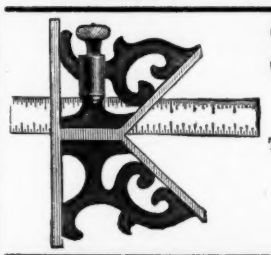

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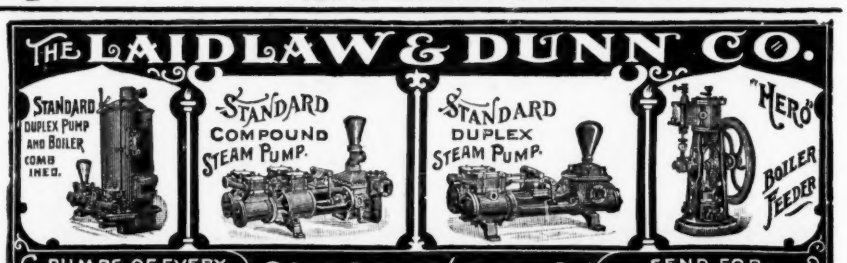

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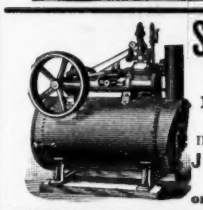

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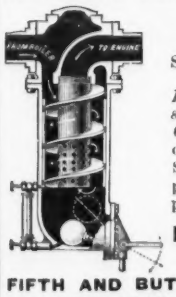

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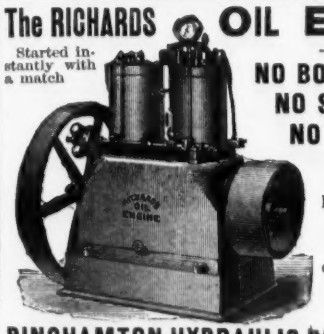

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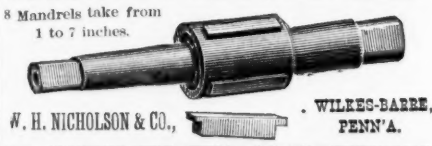

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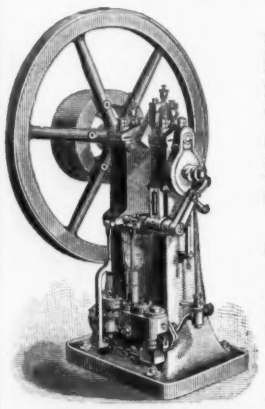

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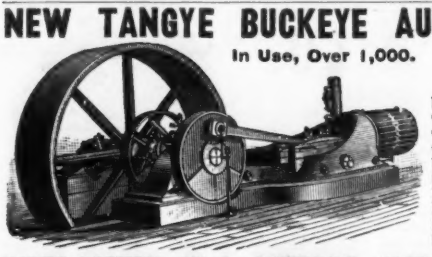

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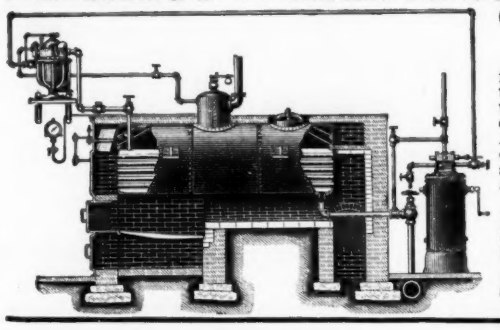

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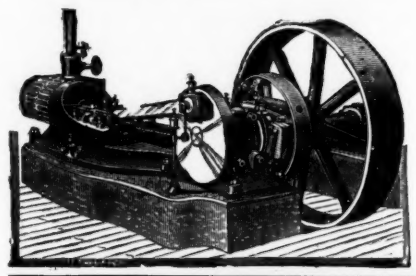

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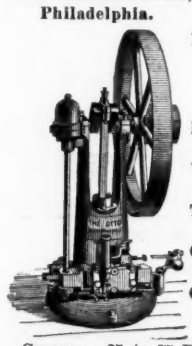

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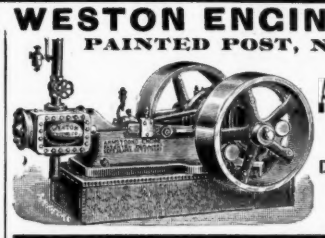

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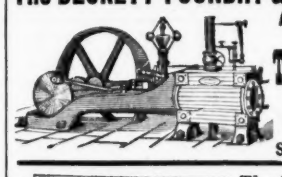

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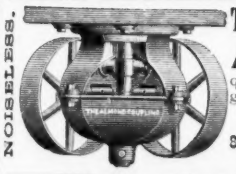

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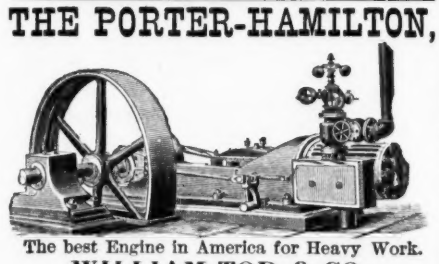

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We have opened at 23 and 25 Purchase St., Boston, in connection with Messrs. Chandler and Farquhar of that city, a depot for the exhibition and sale of our Improved Engine Lathes, Shapers, Drill Presses and Brass Working Machine Tools, &c. We make a feature of Complete Engine Lathes, without charge for extra attachments.

Call and examine them. Cuts, with full descriptions, free.

LODGE, DAVIS & CO.

23 & 25 Purchase St.,

BOSTON.

WORKS, Cincinnati, Ohio.

See Advertisement, Page 16.

MACHINERY ON HAND.

16 in. x 42 in.	Planer.	Bridgeport,	new
20 in. x 5 ft.	"	Lincoln,	cheap
20 in. x 5 ft.	"	P. & W.,	good.
23 in. x 5 ft.	"	Hendey,	new.
32 in. x 5 ft.	"	Powell,	"
24 in. x 8 ft.	"	Powell,	"
30 in. x 8 ft.	"	each Atherton, Powell & H. & P.	new.
6-8-10-12-15 in. Crank Shapers.			
15 x 20 in. Friction Shapers.			
20-24-26 and 32 in. Geared Shapers.			
12 in. x 5 1-2 ft. Engine Lathe,		S. M. & Co.	new.
12 in. x 6 ft.	"	Young,	"
13 in. x 6 ft.	"	Ames,	"
14 in. x 6 ft.	"	Blaisdell,	"
14 in. x 7 ft.	"	Bogart,	"
14 in. x 6 ft.	" Gap Bed,	S. M. & Co.,	"
15 in. x 6 and 8 ft.	"	Porter,	"
16 in. x 6 and 8 ft.	"	Blaisdell,	"
16-20 in. x 8-8-10 & 12 ft.		Bridgeport,	"
18 in. x 8-10-12 ft.	"	Different Makes,	"
20 in. x 8-10-14 ft.	"	Different Makes,	"
20 in. any length Bed	"	Bridgeport,	"
22 in. x 12 ft.	"	Niles,	heavy, good.
23 in. x 8-10-12 & 14 1 2	"	Bridgeport,	new.
28 in. x 14-16 & 18 ft.	Engine Lathes,	T. & S.	"
20 in. Drill		Davis,	"
20-23-25-28 inch Drills		Blaisdell,	"
20-25-28-32 inch	"	C. & S.	"
5 ft. Arm Universal Radial Drill,			"
Cabinet Turret Lathe, Lodge, Davis & Co.			"
No. 5 Screw Machine, Jones, Lamson & Co.			"
No. 2-4	"	Brown & Sharpe.	"
No. 2 and 4 Stiles Punch Press,			good
Ames Index Milling Machine,			fair.
No. 2 Garvin Hand Miller,			A 1.
No. 5 Brainard	"		A 1.
Lincoln Pattern,	"		good order.
No. 1 and 3 Universal Miller, Brown & Sharpe,			new.
No. 1-2 and 5 Plain	"	" "	"
No. 1 Universal Grinder,		" "	"
No. 3 Surface Grinder,		" "	A 1.

Cold Rolled Shafting in Stock. Send for list. Write for what is wanted.

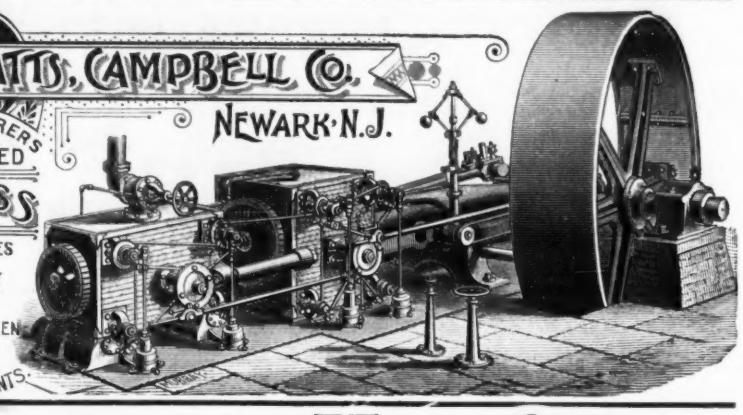
E. P. BULLARD,

62 COLLEGE PLACE & 72 WARREN ST., NEW YORK.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

NEWARK, N.J.



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Complete Motive Power Plants Furnished.

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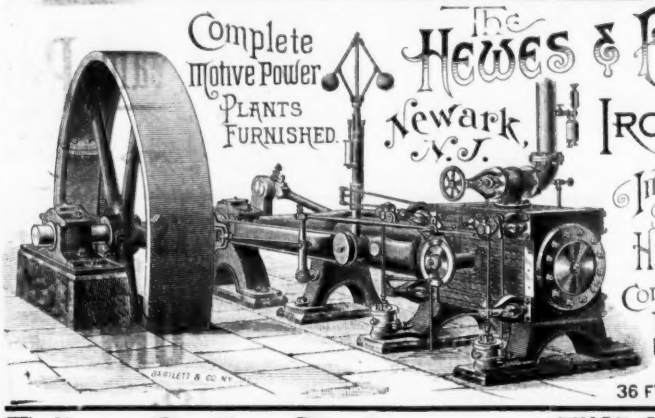

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NON-CONDENSING, CONDENSING COMPOUND.

40 TO 1,000 H.P.

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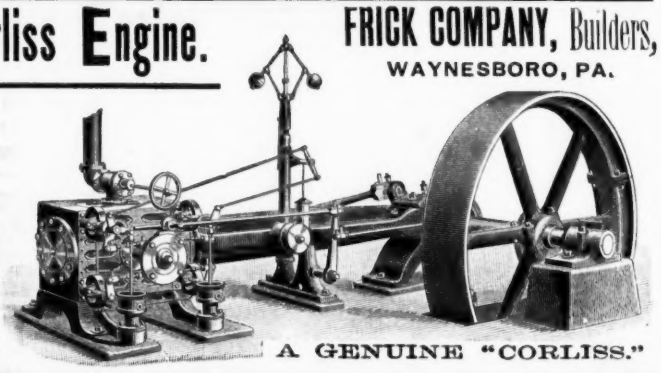

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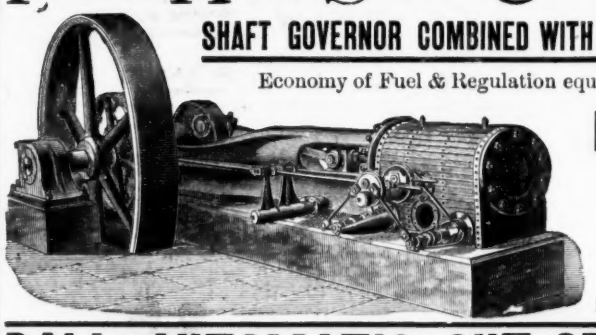
PAYNE HIGH SPEED CORLISS ENGINE.

SHAFT GOVERNOR COMBINED WITH CORLISS WRIST-PLATE.

Economy of Fuel & Regulation equal to anything in use.



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The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.

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ENGINES from 15 to 400 Horse Power

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

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NEW YORK STORE, 46 Cortlandt St.

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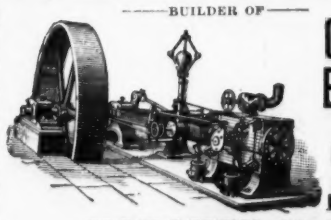

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10" x 5' Engine Lathe,	F. E. Reed.
12" x 5' Engine Lathe,	Prentice, (new).
15" x 6 Engine Lathe,	Lathe & Morse.
16" x 6' Engine Lathe,	Powell.
16" x 6' Engine Lathe,	Blaisdell.
16" x 11' Engine Lathe,	New Haven.
20" x 8' Engine Lathe,	Powell.
21" x 10' Engine Lathe,	Lathe & Morse, (new).
36" x 10' Engine Lathe,	Putnam Machine Co.
Cabinet Turret Lathe,	Lodge, Davis & Co. (new).
16" x 16" x 3' Planer,	Lathe & Morse.
24" x 24" x 6' Planer,	Chamberlin.
26" x 26" x 6' Planer,	Hendey.
30" x 30" x 8' Planer,	Bement.
36' x 36' x 10' Planer,	Whitcomb, (new).
42" x 42" x 10' Planer,	William Gleason.
15" Stroke Shaper,	Hendey.
20" Upright Drill,	Prentice.
22" Upright Drill,	Reed.

Above 2d-hand tools are in first-class condition. Write for list giving prices and descriptions.

We also carry much the largest stock of New Machine Tools in the country.

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BROWN & SHARPE MFG. CO.,

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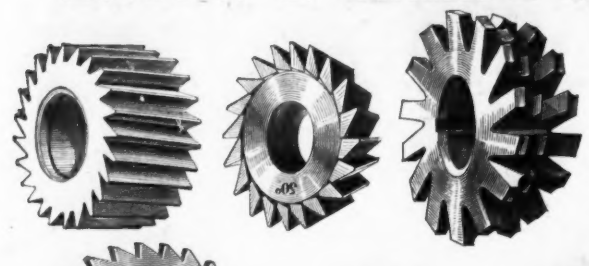

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FOR USE ON

MILLING MACHINES

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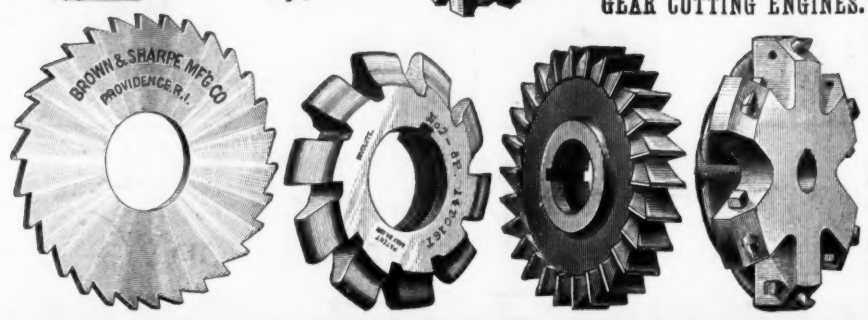

Duplex Steam Pumps

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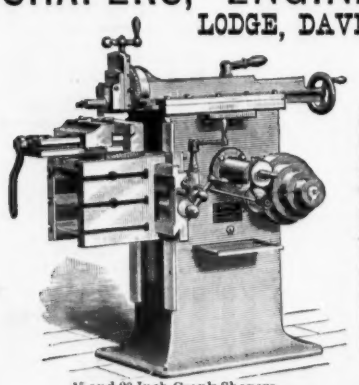

15 and 20 Inch Crank Shapers.

WRITE FOR PRICES, IT WILL PAY YOU.

20 inch Upright Drills. 25 inch Back Geared, and
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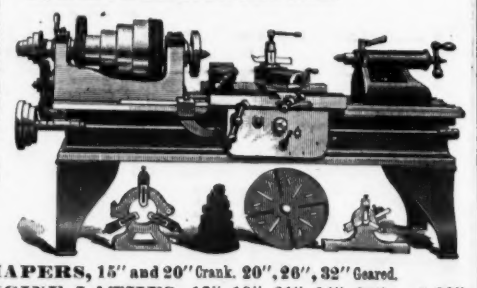
28, 32 and 40 inch Power Feed Drills.



SHAPERS, 15" and 20" Crank. 20", 26", 32" Geared.
ENGINE LATHES, 17", 19", 21", 24", 27", and 38".
(See advertisement, page 15.)

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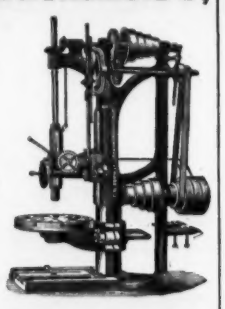

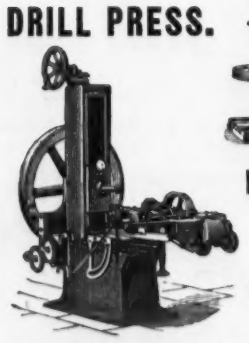

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Sizes, 18", 25", 36", 50", 60", 84".

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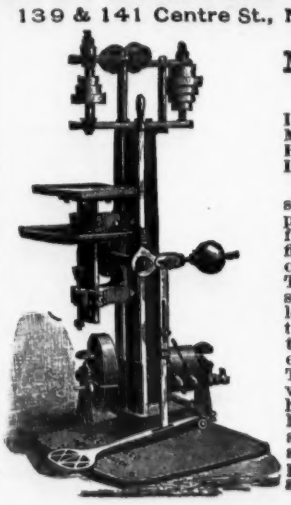

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Including Milling Machines, Drill Presses, Hand Lathes, &c.

The machine shown in cut is especially designed for jobbing, and is fitted up with one or two spindles. Those with two spindles have pulley, with two sections, which gives two speeds to each spindle. Those fitted up with one spindle have a cone pulley with three sizes. The back shaft has a cone pulley with four sizes.

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Manufacture **LATHES** of Various Sizes

AND OF THE FOLLOWING KINDS.

Hand, Engine for Turning and Screw Cutting, Cutting Off, Gap Bed, Pulley Turning and Boring, Turret-Head Engine and Chucking, Hand Wheel Rim Turning, Spinning, Grinding, Pattern Making, &c.

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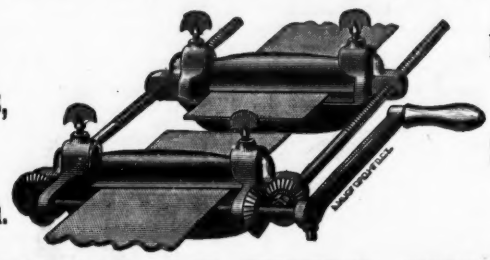

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Formerly of Worcester, Mass.

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A machine shop 500' long by 100' wide; a foundry 250' long by 90' wide; also commodious buildings for the storage of sand, coal, coke and pig iron; ample and convenient wash rooms for the men; fireproof two story pattern storage; blacksmith shop; engine and boiler houses. These buildings are detached from the machine shop and foundry. There is an elevated railroad for the convenient distribution of raw materials, and a railroad running through the machine shop for shipping. The whole plant is supplied with the incandescent system of electric lighting.

The machine shop and foundry have overhead traveling cranes running through their entire lengths; also light traveling cranes, which serve every tool, and a number of jib cranes in the foundry and scratch rooms. The foundry has capacity for making the heaviest class of castings.

All our tools are expressly designed for the economical manufacture of heavy machinery for railroad and general machine shop equipment, from new patterns of the latest and best designs.

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See advertisement, page 13.

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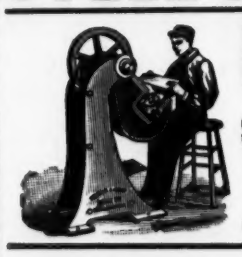

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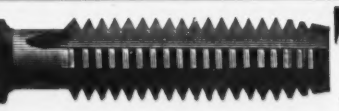

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